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GAS JOURNAL

LIGHT ✦ HEAT ✦ POWER ✦ BYE-PRODUCTS

[Founded in 1849 as the "Journal of Gas Lighting."]

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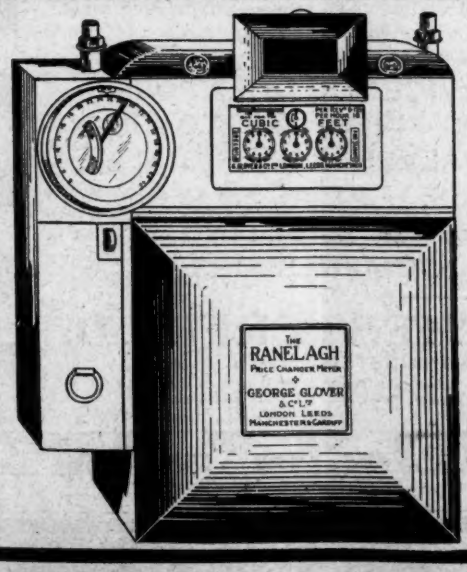

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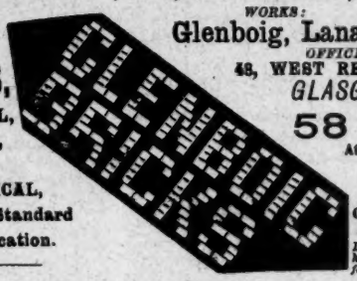

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EDITORIAL NOTES.

Wages in the Gas Industry.

IT is now recognized that economic conditions generally have undergone such a change that the costs of production must be reduced if industries are to live and flourish. The cost of living has been sliding in the right direction; and the price of gas must follow the lead that has been given by other necessaries of life. With the cost of living reduced for the employees of the gas industry as in the case of all other people, it would be impossible to continue to justify much longer the present prices of gas. The industry must look after the interests of the public; for it is only by the goodwill and the patronage of the public that the wages of the employees can be reasonably maintained. There are some gas-workers whose ideas as to wages are extravagant; there are some men who think the power of organization is stronger than economic conditions. If such men could have their way, and were able to control matters by spurious doctrines, they would soon bring the industry to ruin. The only questions are what is right and legitimate in the matter of wages, and what can an industry afford to pay its men to maintain it in a prosperous condition, and so increase rather than diminish the capacity for employment in it. Decline of prosperity means decline of employment; increase of prosperity means increase of employment. High prices for gas do not conduce to greater prosperity; and they will do so to a less extent when the price of coal again falls. The gas industry will have to rely more and more for progress on the fuel value of its primary product in relation to the values of other fuels. The leaders of the men employed in the gas industry fully realize all this; but we are afraid some of the employees of the industry do not. It is as well therefore the points should be made.

Last week the newspapers made a great deal of fuss as to what was transpiring in regard to wages in the engineering trades, the cotton industry, and the gas industry. In the case of the engineering industry, the employers have suspended until the end of the month the reduction of wages of which they had given notice, in order to afford an opportunity for a ballot on the terms. But whatever the result of the ballot, if the engineering trades in the country are to succeed in competition with other countries, the reduction of wages will have to be made. Otherwise, some of the engineering works in the country will have to close-down. The first reductions in the engineering trades, it is proposed, shall be made in periodical instalments. This is a policy of these changing times; and it is a very good one, in order that the step-down in the income of employees shall have an easy instead of a steep gradient. In the cotton industry, an agreement has been effected. With regard to the gas industry, the newspapers have been referring to the position as a wages "dispute." There has been no dispute; there is no necessity for dispute where men are reasonable on both sides. There has been conference, but no dispute. The origin of the report was the intimation of the Federation of Gas Employers that, "in view "of the fall in the cost of living, and also of the imperative "necessity in the interest of the public for a reduction in "the cost of the production of gas, the time has arrived for "a reduction in the wages which are being paid to gas-"workers."

Upon this matter there have been conferences between the representatives of the Gas Employers' Federation and the National Federation of General Workers. There were two long conferences last week; and, quite contrary from anything approaching a "dispute," they were conducted with the utmost friendliness and good feeling on both sides. This is as things should be. We cannot say what the result of the conferences was; this is, at the present time, a matter of confidence between the parties. But it is understood that the outcome of the discussions was that certain resolutions were arrived at which will be submitted to the district delegates, and by the delegates to the men. The proper time for publicity will be when there has been ratification. However, by the end of the month we may expect to hear, and have for publication, something more definite. The representatives of the men quite realize the views of the employers as to the necessity for a decrease in wages; and both sides recognize to the full the necessity for good relations. It may be that what is at this time a general policy in industry may be adopted in this instance, and the reduction be made in steps. More as to this anon. One matter to which reference may be made—this being also a question of current and general policy—is that future wage movements will probably be on a sliding-scale, the basis for which has yet to be determined; and upon this there will be discussion and decision as early as possible. The best friends of the gas-workers (whose work, generally speaking, is as regular as in any industry) will be those who advise them to get as early as possible on to a well-defined basis for wage movements. This will help the industry in its efforts to stabilize itself in these times of shifting conditions; and stabilization will be to the advantage of firm and (let us hope) growing employment.

Of course, whatever reductions are made in future will only apply to those gas undertakings that have complied with the wage agreements made in the industry. This brings us to a reference to zoning and grading. Leaders of the Unions complain that some gas-works are not complying with the agreements in these respects. We are sorry to hear it. We have only heard of a few cases where this is so; and we believe that such cases are really few. A notorious instance is a city in the West Riding; and it is understood that it is the only undertaking in the area that has deserted the agreement. It is a pity. Example stands for much; and neither the Federation of Gas Employers nor the representatives of the men's Union can work to the best effect while abandonment of this kind occurs. Such proceeding is the cause of much trouble to the whole industry. It adds to the difficulties at conference with the leaders. Naturally the point is made that if gas undertakings break-away from agreements, how can the leaders of the Unions expect universal fidelity from the men in respect of the agreements to which the leaders are parties, and how can they effectually prevent unauthorized strikes? Neither they nor gas undertakings want to have a repetition of events which caused so much disorganization in gas supply up North last year, and which events were creditable to no one. The Gas Employers' Federation want complete fulfilment of agreed obligation on the part of gas undertakings; and the leaders of the Unions desire the same thing from their men. These are conditions which will not be secured while there are gas undertakings which will not honour collective arrangements and agreements.

Falsified Hopes.

THE miners have falsified all the expectation of those who believed they were in a position to form a fair estimate of what would happen if a ballot of the men were taken. The anticipation was that there would not be a two-thirds majority in favour of continuing the coal strike; but of the 616,338 men who voted, there were 432,511 against acceptance of the terms offered, and 183,327 for, which figures give

more than a two-thirds majority in favour of prolonging discord and a disastrous state of affairs. A study of the figures, however, supplies ground for the assumption that there were very effective under-currents at work to draw those to the ballot-boxes who could be relied upon to vote against acceptance rather than to bring up to the scratch those who were favourable to a resumption of work on the good terms offered. The total membership of the Federation is 957,610, so that the 616,338 who voted represents only 64·36 p.ct., or rather less than two-thirds of the membership. The number of those who did not vote was 341,272, or more than half the number of those who did. We have no doubt that some of this number were apathetic, and did not care much which way the vote went. There is pretty conclusive evidence, too, that the ballot was taken in a slipshod, primitive fashion. Some of the men were far from the balloting stations; some did not know when the ballot was to be taken; and the crude fashion of issuing the ballot forms in some districts enabled, so it is stated, individuals to record a vote more than once—some reports allege several times. Anyway, it may be taken that a large proportion of the 341,272 who did not vote were neutrals. If this 341,272 could be added to the 183,327 who voted for the owners' terms, we arrive at a figure of 524,599, or 54·78 p.ct. of the total membership of the Federation, which shows that the ballot does not reflect with any degree of positiveness the views of the mining communities. [Since dealing with these figures, it is understood that in the official announcement an error was made, which transfers 3103 from the number voting for acceptance to the number voting against. This has no effect on the argument in the foregoing.]

The figures render the position of the Executive of the Miners' Federation one of great difficulty. It is well known that the Executive were in hopes that there would be acceptance, thus enabling them to get out of a situation that has become untenable. The ballot so far as it went means that the Executive have been defeated by the extremists of the local Councils—the men who have attempted so much to bring ruin upon the mining industry, and to injure the industrial interests of the country. They have been completely successful in impoverishing the miners' organizations, and the men themselves. There is no money in the till, and little in the pocket now; and the time-limit for the £10,000,000 subsidy has expired, unless the Government can be prevailed upon to revoke their decision in view of the prediction that a large number of miners will now break away, and will resume work. If this happens, it will create a position for the Executive of the Federation which will make the ballot and all they have been fighting for and holding-out for a perfect fiasco. Everything at the moment is in a nebulous state. No one knows what will happen; and speculation is equally as unprofitable now as it was before the ballot was taken. But it is a fact that there are many thousands of miners eager for work; and once there is a movement to the pits of encouraging proportions, the return march will soon gain in momentum. In some districts repairs and pumping have been going on during the past week in the anticipation that work would be resumed this week. There will be large numbers of the miners who will not again find occupation in the collieries, which (as production *per capita* compared with 1913 proves) were overmanned before the strike. Some pits have been destroyed; and some have a working life which would not justify the expenditure upon them of a heavy amount of capital in restoration. There will be much heart-burning. If such a large number of the miners were not so apathetic, there would be serious accounts to settle with those who have so efficiently filled the rôle of misleaders in this most miserable business.

Within twenty-four hours after the announcement of the result of the ballot, there was a fresh development; but there is widespread confidence that it will come to nothing. The miners' leaders see that the game is up in endeavouring to secure for the miners conditions which the coal industry cannot afford, and that would give to the miners treatment of a character that cannot possibly obtain in any other industry. They are now speculating upon the leaders and members of other trade unions being as rash and wild as they are themselves; and we fancy this must be the last move in the great gamble. After hearing the result of the ballot, the Premier informed the Executive that the offer of the subsidy could only continue open until Sunday evening. When the extension of the time-limit expired, the miners had deliberately thrown away the £10,000,000, which would have helped them materially over the difficulties of the next few months of restoration. Before the extra day was given within which to grasp or reject the offer, the Miners' Executive had decided to invite the executives of other unions currently concerned in wages discussions to meet them at an early date, with the object of taking national action to secure their "mutual demands," which can only mean "direct action." There is little that is "mutual" between the demands of the other unions and those of the miners. The railwaymen and the transport workers found the miners' representatives so extravagant, despotic, undiplomatic, and erratic, that they could not discover any common ground on which they could take serious action in their support. As to other unions, the miners' leaders have dealt such a blow at industry and employment generally, and have made conditions go from bad to worse, in vainly trying to make their demands supersede the new economic circumstances, that labour leaders generally will fail to see any use in forming an alliance with an organization that has had little or no consideration for anything but its own arbitrary policy. Other Unions have troubles enough of their own—partly originated by the miners—without coupling themselves up with the mass of difficulty (in the making of which they have had no share) in the coal industry. The miners have been offered good terms, including the Government subsidy, the sacrifice of profits on the part of the colliery owners during the period of restoration in those areas that are hit the hardest, and profit-sharing. But the miners have not shown any disposition to respond by offering to work up to the standard of production per man that obtained in 1913. The other Unions know that it will be futile to search for grounds on which there can be a mutual movement. They know, too, there is nothing to be gained by making things worse than they are, which is the policy of the revolutionary. The invitation of the Executive of the Miners' Federation is a confession of inability to carry through their policy without external aid.

Recording Calorimeter Research.

TO-DAY we commence the publication of the fifth report of the Sub-Committee of the Gas Investigation Committee of the Institution of Gas Engineers and the Leeds University. As is now well known, this report deals with an investigation into the accuracy and general reliability of recording calorimeters, and particularly of the Simmance total-heat instrument of this class. The work has been in the capable hands of Mr. James W. Wood, M.Sc.; and he has produced a veritable text-book on the subject. As a matter of fact, this is the first serious study of which we have knowledge of the principles, design, and action of this particular class of calorimeter. Mr. Wood is deserving of the encomiums which the Committee have already bestowed upon his investigation. He has here gone back to fundamentals, and carries us from them along to result. This is what gas engineers and gas chemists want in a matter with which—though recording calorimeters have been on the market for some time now, and have been in use with varying success—they will have to become more intimately acquainted, in view of the fact that such instruments are to be the arbiters between the seller and the buyer of therms under the Gas Regulation Act. The report will be valuable not only to the users, but to designers, as it points to where the sources of defect may arise, and therefore the directions in which attempts should be made to obviate defect and error. It also emphasizes the supervisory part that users must take in helping to ensure accuracy. Of course, there may be features of the report which experts in the design and use of such recording instruments may be able to criticize. It is admitted frankly that we are not prepared to say all that is contained in the report is unassailable or beyond criticism. The investigation has been limited in time, in instruments, and under specific conditions of gas supply; and it has to be carried farther before it is possible to declare that everything in the report would apply to any and every instrument and to all conditions. This is not claimed.

It is well before reading the report to be fortified with the knowledge that recording calorimeters have been described which show on long trial—trials continuously made over some months—an accuracy variously of ½ p.ct., 1 p.ct., 1½ p.ct., and 2 p.ct.; that the Simmance continuous total-heat recorder is credited in the report itself with giving results in some cases showing equality with, and in others only fractions of 1 p.ct. variation from, the readings of a Boys' and

a Junkers' calorimeter; and later on results (uncorrected for temperature and pressure) with the Beasley calorimeter are shown to compare well with the results from the same instruments, though further evidence, it is stated, is required to enable one to speak positively of it. In the case of the Simmance continuous calorimeter, we have the testimony of the Board of Fuel Research that the accuracy was well within 2 p.ct.; and this instrument, like the one that Mr. Wood has had under observation, was not the latest type of the Simmance recorder in which have been incorporated improvements which assist to cancel-out certain of the defects and influences which oppose a consistent accuracy without strict supervision over details. But such improvements have been made; and they have to be borne in mind, when considering the substance of the report and the statement that, "although so good an instrument in many respects, "the recorder we tested could not, in our opinion, have been "rightly made the basis of monetary charges or penalty "clauses under the Gas Regulation Act, *unless* under "special conditions, and subjected to continuous skilled "supervision." This is the view formed from tests under Birmingham conditions; but it does not exactly square with the experiences recounted in the Board of Fuel Research report upon tests under the conditions at the Fuel Research Station. Practically, the same statement is made concerning the Beasley calorimeter—that it is "a useful instrument "for the control of gas manufacture, but, from some errors "to which it is liable, unsuitable for official purposes." Furthermore, regarding the Simmance instrument, Appendix II. of the report will be found to contain an indication of additional improvements which have been made; and it is preceded by the statement that, "while our investigation "has been in progress, the makers also have been experi- "menting independently, and collecting evidence as to the "behaviour of instruments supplied to their clients in vari- "ous parts of the country. In consequence, later instru- "ments show some considerable improvement in design and "in accuracy of their records." These are points that must be borne in mind in considering the main part of the report and the conclusions drawn chiefly from an instrument which does not embrace the latest improvements, and therefore which does not compass the present state.

Reading the report, one might be disposed to think, without bearing in mind actual results under given conditions, that the chances of getting a thoroughly reliable continuous recorder in any circumstances are very remote. The many difficulties that oppose are prominent all through. No man is more conscious of them than Mr. Simmance, who passed, we might say, through years of disappointment in work directed to this particular subject, before he reached that which he was striving to attain. There are sources of difficulty inherent to such instruments; they are also subject to the outside influences of atmospheric temperature and pressure; and there are the varying conditions (including compositions) of gas supply, and of the characteristics of the water, where water-flow calorimeters are used. The difficulties that are inherent to the instruments themselves are largely organic ones; but the latest type of Simmance recorder shows that design of certain details and change in physical structure can overcome them. For example, both in this report and in that of the Board of Fuel Research [see "JOURNAL" for March 23, p. 739], allusion is made to burner troubles which were traced to particles falling on to the gauze of the burner, owing to corrosion in the flue tube. The Board of Fuel Research report recommended the altering of the shape of the burner head, so that the particles would not find a place of lodgment there. But the makers have gone one better, and now construct the combustion chamber of silica tube, so that the very source of the trouble has been removed. Then as to variations in the rate of flow of the gas, the Board of Fuel Research report stated that the claim that the gravity meter automatically applied a correction for the gas was approximately true. In his report Mr. Wood, in dealing with the vital components of a continuous recorder, pays considerable attention to the governor. It is clear, however, from what he says that considerable caution will be necessary in dealing with some of the heavier gases now produced as the result of steaming charges, or adding a notable quantity of inerts, both of which may lead to an increase in the specific gravity of the gas sufficiently great to impair the accurate working of the governor with respect to compensation for temperature and pressure changes. As to the water flow, here, again, a new device has been applied to keep the rate constant. One cannot, of course, blame calorimeters of this kind for inconstancy due to outside causes, chemical and physical—for instance, changes in gas composition. Though changes in specific gravity are largely provided for, they may be so steep as to reduce the degree of accurate working of the instrument. But, on the other hand, we have Mr. Wood giving credit for the manner in which the recorder responds to heavy changes in calorific power. Then in instruments of the water-flow type, the chemical characteristics of the water may be detrimental—for example, moorland waters have corrosive effects. The presence, too, of foreign substances in, and the viscosity of, the water, are impediments to constancy in operation and result. Given water of unblemished character in all these respects, it will not be a difficulty. There are also the extremes of atmospheric temperature and pressure; and there are the heat losses which vary with changes of external temperature.

The report shows conclusively that the recording calorimeter has to contend with an aggregate of very difficult circumstances, which may vary with time in one undertaking, and as between works in one locality and another. Consideration must be given to this; and proper supervision and adjustment must be accorded, or there will be trouble of a cumulative order. We are hoping, so far as variations in gas supply are concerned, that the Gas Regulation Act and the recording calorimeter between them will do a great deal to eliminate much of the irregularity, and so produce conditions more congenial to continuous calorimeters. The work the Research Sub-Committee and Mr. Wood present in this report is not only highly opportune, but of considerable worth. The knowledge of difficulty promotes efforts to remove it; and this leads to greater perfection in result in differing circumstances. We do not expect on the road of progress to accomplish all things at once that are necessary to, or are accompaniments of, a new stride.

Coal from Abroad.

THE importation of coal from abroad has had its lessons, although the industry has had to pay dearly for them. The importation was something new to this country. Coal has even been carried to Newcastle, and to other places with large coal-pits in the neighbourhood. The volume of the inflow has increased remarkably; and there has been quite keen competition to get the business—in fact, the importers have been anxious to become known to gas undertakings through the National Gas Council. In this innovation in trading in the British coal market, competition and the law of supply and demand have begun to be felt. The importers have developed their organizations for the trade with a promptitude which merits recognition. Through this, the very high prices that ruled at the initial stages of the business have declined. Of course, the coal from America demanded, for economical carriage, ships of large tonnage; and this has given rise to suggestions for co-operative purchase by the smaller and medium-sized gas undertakings which could not contemplate handling individually such large cargoes as those that were on offer. There has been plenty of information circulated as to how to secure the coals. To obtain possession was an important matter. But what was also wanted was something highly important, and that is definite and reliable particulars and guarantees as to quality. In many cases there has been little relativity between quality and price. There are good American and Continental gas-making coals; and there are very bad kinds. Ash and sulphur have varied widely between different deliveries. Gas yields have moved between (say) 8000 c.ft. and 12,500 c.ft. in the same retorts. The coke-making qualities have had similar large variation. Some of the German coals have shown good makes; certain of the French and Belgian varieties very poor ones. Low production per ton and per mouthpiece have heaped-up the anxieties of the gas manager; and the stokers have uttered things that have not been complimentary. But they know that it is this or nothing; and that the fault for the poor makes and other troubles is not due to any neglect on their own or their officers' part. So they swallow, as best a stoker can, the bad reward to good effort to secure normal results out of indifferent material. Our youthful experiences of dipping into the "lucky bag" have been repeated in the case of imported coal. There will—at any rate for a time—still have to be some reliance on coal from abroad. When the British miners set to work again, the volume of output will be small at first, and the capacity for absorption will be great.

It will take time for satisfaction to be given throughout the country; and so the trade in imported coal will, we imagine, go on for some time yet. It is, to say the least, wonderful that the country has carried on so well as it has for twelve weeks with its own collieries unyielding.

Visit to the Fuel Research Station.

We fancy there will be a large acceptance, by the gas engineers who are conveniently located, of the invitation by Sir George Beilby, F.R.S., Director of the Fuel Research Department, to visit the Fuel Research Station on the afternoon of Wednesday, June 29. What has to be done to form one of the party will be seen by an intimation on another page. The work that has been done, and is going on at the station, is so big with interest to gas engineers that we are sure they will be pleased to inspect the scene of so much activity.

Leeds University Finance.

We are sorry to read the report in the papers that the Vice-Chancellor of the Leeds University (Sir Michael Sadler) has had to make, that this seat of learning and industrial benefit is in danger of bankruptcy. For the financial year ending July 31 next, the University will show a deficit, including one brought forward, of £14,000. Savings will have to be sacrificed in order to enable next year to start with a clean sheet. But at the end of July, 1923, if the fees remain at the present low rate, there will be a deficit of about £16,000. That a University which is an essential to the life of the nation, seeing that its benefits are not confined to the students, should be placed in a position in which it cannot make ends meet, appears to us to be little short of a public scandal, more especially when we know that many of the salaries paid to the teaching staff are still below the level required to ensure the retention of teachers of high qualification, and to induce new recruits to enter the same profession. To recompense adequately the professors and teachers, and to make the profession attractive to men of brains, some £10,000 to £15,000 a year more will be needed by the University. There must be intellectual efficiency. To secure it, not only will the fees of students have to be raised, but the support from industrial beneficiaries must be increased.

Co-Partnership and Trade Unions.

This is a matter that has been discussed on various occasions, and particularly by Dr. Carpenter in his paper before the British Association on Sept. 11, 1913. There has been a case proceeding in the Law Courts in which certain co-partners of Messrs. Lever Bros., Ltd., were the plaintiffs, and certain Trade Unions the defendants. Perhaps we ought to mention the names of these Unions. They are the Amalgamated Society of Carpenters and Joiners and the General Union of Operative Carpenters and Joiners. It is as well they should be known, as all trade unions are not so foolish as to want to banish from their ranks men who are co-partners. There are some trade unions who would suffer immensely in their membership if they did anything so absurd. They welcome members whether they are co-partners or otherwise. It ought to be to the interests of the unions by fair and legitimate means to make industry as profitable as possible to their members. The two Unions in question sought to exclude the plaintiffs from membership because of their position as co-partners in the firm named. In the Lower Court, Mr. Justice Eve held that the two Unions were illegal, in the sense of being in restraint of trade under section 4, sub-section 1, of the Trade Union Act, 1871; and in these circumstances the actions were not maintainable. So he dismissed them. The defendants also attempted to justify their action under their own rule 32, sub-section 1, which gives the executive power to expel any member for working on a co-partnership system in which the workmen hold only a minority of the shares. The workmen employed by Messrs. Lever Bros. are paid the full trade union rate of wages; and they work trade union hours. They have no right to demand participation in the co-partnership scheme; but meritorious men can apply for partnership certificates, and obtain shares from the trustees, who are also the Directors. Having obtained such shares, they receive interest upon them. Is this a co-partnership? asked the Master of the Rolls. He can find no satisfactory definition of what a "co-partnership" is. His Lordship would be told by the men known as co-partners in the gas industry that the meaning they attach to the word is sufficient for them. However, the question of definition is not important; what is important here is that the Court of Appeal held that the injunction must go. The plaintiffs are therefore maintained in the membership of the Unions.

Engineering Wages Ballot.

In view of the incidental reference, in the editorial article on wages in the gas industry, to the ballot of the workers in the engineering trades, and as the gas industry is largely dependent for supplies of plant on the trades affected, it will be of interest to place on record the terms on which the ballot is being taken. It is proposed by the employers that the following reductions shall take place: (1) The 12½ p.ct. and 7½ p.ct. Ministry of Munitions bonus shall be withdrawn—4·16 p.ct. and 2½ p.ct. respectively at the commencement of the first full pay in July, 1921; 4·16 p.ct. and 2½ p.ct. respectively at the commencement of the first full pay in August, 1921; and 4·16 p.ct. and 2½ p.ct. respectively at the commencement of the first full pay in September, 1921. (2) Three shillings off time rates, and 7½ p.ct. off piecework rates at the commencement of the first full pay in October, 1921. (3) Three shillings off war bonus of 26s. 6d., when the Ministry of Labour index number of the excess cost of living arrives at 115 p.ct., but not earlier than the beginning of the first full pay in November, 1921.

Semet-Solvay Ovens and Complete Fuel Service.

In the course of an article illustrated by a photograph of a battery of Semet-Solvay bye-product ovens at Chattanooga, which appeared in a recent issue of the American "Gas Age," Mr. C. R. Bellamy, of Syracuse, remarked that the gas industry has now reached a crisis where it must make a big decision. If the cost of oil and other materials makes carburetted water gas prohibitive at present rates, and if these rates cannot be increased without bad effects, then there is just one alternative left to the gas company. This is to adopt a process for manufacturing gas which, with existing conditions, will supply the incentive needed for financing and developing the business. In short, the best and cheapest method of manufacturing gas must be sought for, and adopted as soon as it is found. In reviewing the development of the gas industry during the last ten years, Mr. Bellamy finds it interesting and encouraging to note that this search for a new process has been vigorously carried on, and that a great many companies have already "crossed the Rubicon." The significant thing about this change is, to his mind, the large number of undertakings which have turned to the bye-product coke and gas oven as a means of development along the lines of true efficiency. For example, from Semet-Solvay bye-product coke-ovens gas is being supplied for domestic purposes to no less than fourteen towns and cities in the United States. In several of these places the gas company buys gas from the bye-products coke company; while in other cases the coke ovens have been built and operated by the public utility undertakings themselves. There are many reasons why coke-oven gas is the logical one with which to meet present-day standards. Like carburetted water gas, it is ideal in its behaviour throughout distribution, because all troublesome compounds are removed in the bye-product recovery treatment. In the change from carburetted water gas to coke-oven gas, all the essential qualities of a domestic gas are retained, while the cost of production is brought to a minimum.

Recent Wills.—Mr. William Bince Randall, of Wood Green Park, Cheshunt, gas engineer and nursery gardener (formerly Engineer, Manager, and Secretary of the Waltham Abbey and Cheshunt Gas and Coke Company), who died on March 17, aged 57, has left a fortune of the gross value of £236,692. Dr. William Odling, for forty years Waynflete Professor of Chemistry at Oxford, who died last February at the age of 91, left estate of the value of £47,587.

The Carba Stella Producer.—The "Technical Review," quoting from "Technik und Industrie," says the Swiss concern, the Schweizerische Kohlensäurewerke A.G., Bern-Liebefeld, has introduced a highly efficient and reliable automatic gas-producer marketed as the Carba Stella producer. The principal part is a cylindrical water-tank with floating bell, also acting as a gasholder, and one or two retorts which must be occasionally replenished with carbide. Water is admitted to the retorts through a perforated tube fixed in the centre of the gasholder; the connection being made by means of a flexible tube in such a manner that the perforations are submerged when the gasholder is low in the water—that is, when the gas supply is nearing exhaustion. Water then flows to the carbide retorts through the perforations, resulting in an increased production of gas, and the gasholder with the perforated pipe being raised, terminating with stoppage of the water supply to the carbide retorts. The water-regulator, which is free from complicated parts, readily maintains a supply of gas according to demand at an even pressure, which is essential to success in acetylene welding operations.

THERMAL EFFICIENCY OF BLUE WATER-GAS MAKING AT BIRMINGHAM AND FULHAM.

DIPPING again into the sixth report of the Gas Investigation Committee on the research into blue water-gas manufacture, and making comparisons with the paper by Mr. E. G. Stewart (of the Fulham works of the Gas Light and Coke Company) which appeared in the "JOURNAL" for March 30 last, it seems to us neither the report nor ourselves in the editorial columns last week fairly represented the information given in Mr. Stewart's paper.

Looking again at the figures, it appears that, in our article, we quoted Mr. Stewart's calculations from Mr. Glasgow's figures as his own tests. That was wrong; but, though we do not as a rule like to take refuge behind others, this was a natural slip from the reference in the report. Certainly one would not gather from the report that Mr. Stewart's paper was on the same subject, and that he also gave working results of a waste-heat boiler! Perhaps we can do better justice to the paper than we did last week by making a comparative statement (with some notes) derived from Mr. Stewart's own blue water-gas tests as published in March last year with one of the Birmingham tests as given in the report.

Comparison of Birmingham Thermal Efficiency Blue Water-Gas Test No. 2 with Similar Tests on the Fulham Plant as given in Mr. Stewart's Paper published in the "JOURNAL" for March 30, 1920.

TABLE VIII.

	Birmingham.		Fulham.
a . . .	5·456	..	5·06
b & *c* . .	1·066	..	1·36
d . . .	0·005	..	0·01
	6·527	..	6·43
1	3·050	..	3·00
2 and 3 .	0·232	..	0·28
4 . . .	1·313	..	0·70
5 . . .	0·340	..	0·46
6 and 7 .	0·320	..	0·34
8 . . .	0·383	..	0·66
9 . . .	0·405	..	0·63
10, 11, 12	0·091	..	0·06
13 . . .	0·393	..	0·30
	6·527		6·43

TABLE IX.

Birmingham.		Fulham.
83·59	..	78·69
16·34	..	21·15
0·08	..	0·16
100·00	..	100·00
46·73	..	46·66
3·55	..	4·35
20·11	..	10·89
5·21	..	7·15
4·90	..	5·29
5·87	..	10·26
6·21	..	9·80
1·39	..	0·93
6·03	..	4·67
100·00	..	100·00

Efficiencies of gas production:

	Birmingham.		Fulham.
Fuel for steam accounted for	(*a*) 46·7	..	46·7
„ „ not „ „	(*b*) 55·9	..	59·3

In the Birmingham investigation, the efficiencies are based upon the gross consumption of fuel. Mr. Stewart apparently preferred to calculate efficiency upon the net consumption of fuel in the generator, which increases the figures somewhat:

	Birmingham.		Fulham.
(*a*)	50·0	..	51·7
(*b*)	60·4	..	67·7

The greater difference in efficiencies (*b*) would seem to arise from the fact that at Birmingham steam is only included for the generator and blower, while at Fulham the steam to operate the whole of the machinery is included.

The potential heat loss in the blow gases is considerably less in the case of Fulham. The total heat losses there which can be passed through a waste-heat boiler amount to 1·44 therms per 1000 c.ft. of water gas made, and 90 lbs. of steam at 100 lbs. pressure were obtained therefrom—a figure which we found recently, when looking into this subject, is still being maintained. Discussion may therefore be expected as to why at Birmingham, with a somewhat larger loss of 1·885 therms only 74 lbs. of steam are anticipated from calculation.

VISIT TO THE FUEL RESEARCH STATION.

MEMBERS of the Institution of Gas Engineers are invited by Sir George Beilby, F.R.S., the Director of the Fuel Research Department, to visit H.M. Fuel Research Station at East Greenwich, on Wednesday, June 29, at 3 p.m.

All wishing to take part in the visit are requested to notify the Secretary of the Fuel Research Board, Nos. 16-18, Old Queen Street, Westminster, S.W., as soon as possible, but not later than Saturday, June 25.

The Institution have made arrangements for motor coaches to leave No. 30, Grosvenor Gardens, Westminster, at 2.15 p.m., for East Greenwich, at a charge of 4s. for the journey. Remittances to be made to the Secretary of the Institution, No. 30, Grosvenor Gardens, Westminster, S.W.

The "Engineer" has been informed by Messrs. Cadbury Bros., of Bournville, Birmingham, that they have started a large Westinghouse gas-engine, about twenty years old, on petrol, and are getting very good results with it under the new conditions.

PERSONAL.

A portrait of the Hon. CLIVE BIGHAM, C.M.G., C.B.E., the new Director of the Gas Light and Coke Company, appears in the "Co-Partners' Magazine." He is the eldest son of Lord Mersey, and as a soldier, diplomat, and traveller, has gained experience of men and things in many lands.

Mr. B. CARS has resigned his position as Managing Director of the Welsbach Light Company, Ltd. Mr. H. TALBOT has been appointed General Manager of the Company.

Mr. MATTHEW DUNN, consulting gas engineer, of Stockton-on-Tees, is the only candidate put forward for a seat on the Town Council, in the place of Councillor J. M'Naughton, who becomes an Alderman.

OBITUARY.

JOHN MACKAY.

We have received news of the death, in Manchester, on Tuesday, the 14th inst., of Mr. John Mackay, partner in the old-established firm of Messrs. Alder and Mackay, Ltd.

Mr. Mackay received the early part of his education in the North of Scotland; but going to Edinburgh in the middle seventies he finished his course at a private school there. When about seventeen years of age, he entered the works of Messrs. Alder and Mackay, of which firm his brother, Mr. Alexander Mackay (well known throughout Great Britain to the gas engineers of that day), was partner. Here he gained a knowledge of gas-meter manufacture which was to stand him in good stead in years to follow. About 1881 he went to Aberdeen to study gas engineering under the late Mr. Alexander Smith, at that time one of the most noted men in the gas profession in Scotland. After spending some years in the "Granite City," Mr. Mackay was appointed Assistant to the late Mr. James Hislop, Engineer and Manager of the Partick, Hillhead, and Maryhill Gas Company, now embraced in the Glasgow Corporation gas area. A short time later, on a vacancy occurring at Peterhead, Mr. Mackay became Engineer and Manager there, and filled the position for several years, with great satisfaction to the Corporation. During this period, the question of enrichment by the oil process was under keen discussion; and he conducted many experiments in the endeavour to obtain the best results from practical working.

In 1892, Messrs. Alder and Mackay approached Mr. Mackay to become one of their representatives; and after considering the matter, he decided to throw in his lot with the firm. On leaving Peterhead, he was presented with many substantial tokens of the respect and esteem in which he had been held by the community of the burgh. He was not long in establishing for himself a wide circle of friends in his new sphere, and very shortly thereafter he became a partner in the firm. With his previous experience and the knowledge he could bring to bear upon the business, he was able to foreshadow the requirements of the future; and he was conjoint in many of the patents taken out by the firm for improvements effected—especially upon slot-meter mechanism.

Mr. Mackay was an ardent freemason, and one of the founders of the Northern Star lodge, of which he eventually became W.M. He was also W.M. of the "Acacia" lodge, at Bradford, and was an affiliated member of the Evening Star lodge.

Sir THOMAS WRIGHTSON, Bart., who died last Saturday at Neasham Hall, near Darlington, aged 82 years, was a well-known engineer in the North of England, and until his death was the active spirit and Chairman of Messrs. Head, Wrightson, & Co., of Stockton-on-Tees.

Intimation has been received by cable of the death of Mr. EUGENE MEUNIER, at Colombo, Ceylon. The deceased, who was the son of Mr. S. Meunier, of Stockport, was 37 years of age; and the message stated he had passed away on May 25. After serving articles with his father at the Stockport Corporation Gas-Works, Mr. Meunier was appointed Chemist at the Stretford Gas-Works, and then Assistant Engineer. Later he became Engineer to the Chapel-en-le-Frith and Whaley Bridge Gas Company, and a year-and-a-half ago was appointed Assistant Engineer to the Colombo Gas Company. He was unmarried.

A Therm Advance in South London.—The consumers in the South Metropolitan Gas Company's area have been notified of an increase of 10 p.ct. in the price of gas from the midsummer quarter—from 10½d. to 11½d. per therm. This exceeds the basic price by ½d.; but if profits will allow, this will not interfere with the minimum dividend of 5 p.ct. The increase is said to be temporary, and is due to the decreased value of residuals, the mines' stoppage, and the cost of imported coal.

Gas for Brooder and Incubator Houses.—An account of the gas equipment at the Black Lake Poultry Farm, Egham, forms the subject of issue No. 88 of the British Commercial Gas Association's "Thousand-and-One Uses for Gas." An illustrated description of Mr. Thomas Potterton's installation on this model farm appeared in the "JOURNAL" for March 2 last.

SIXTH REPORT OF THE RESEARCH SUB-COMMITTEE OF THE GAS INVESTIGATION COMMITTEE OF THE INSTITUTION OF GAS ENGINEERS.

BELOW we conclude the publication of the Sixth Report of the Research Sub-Committee of the Gas Investigation Committee, which was to have been submitted last month to the Institution of Gas Engineers. The first portion appeared in our last issue—pp. 619-627.

SECTION II.

THE COMPOSITION OF WATER GAS AT THE DIFFERENT STAGES OF MANUFACTURE.

It is well known that, owing to the falling temperature in the fuel bed, the water gas made in the ordinary intermittent process undergoes considerable change in composition from the beginning to the end of each run period. Further, unless the heat restored to the fuel bed during the blow is equivalent to that absorbed during the run, changes in the average composition of the gas made occur from one run period to another. The successful operation of a water-gas plant is therefore largely dependent on the particular cycle of operations combined with suitable rates of admission of air and steam to the generator during the respective blow and run periods. The changing depths of fuel from one charging of the generator to the next must also be considered; and allowances must be made for the cooling effect of the coke added, and the heat lost during the clinkering periods. For the purpose of ascertaining whether the cycle of operations adopted during the efficiency tests was well balanced, a comprehensive investigation into the nature of the changes occurring in the composition of the water gas at the different stages from one clinkering period to the next was carried out. Throughout the investigation, readings of pressure-gauges and steam-meters were taken, to ensure that the conditions were as nearly as possible the same as those prevailing when the complete tests were made. The cycle of operations adopted is described in detail in Section I., under the heading "Plant Routine."

The water gas made from one clinker period to the next was first sampled in nine successive stages, as follows:

(*a*) Six separate and successive coking-to-coking periods, each comprising one 3½-minute up run and six or seven normal 4-minute up-down-up runs.

(*b*) One period comprising one 3½-minute up run and three normal 4 minute up-down-up runs.

(*c*) One period of four 4-minute up runs.

(*d*) One period comprising one 3½-minute up run and three 4-minute up runs.

The results of analyses of the samples obtained appear in Table A.

TABLE A.

—	(*a*) Coking-to-coking periods.						(*b*)	Up Runs.		(*d*)
	36 Mins.	41 Mins.	41 Mins.	41 Mins.	41 Mins.	41 Mins.	21 Mins.	(*c*) 20 Mins.		21 Mins.
CO_2	3·20	3·10	3·0	2·90	3·5	3·50	3·3	5·50	Generator charged.	4·45
C_mH_n	0·05	0·05	..	0·05	..	0·05	..	0·05		0·05
O_2	0·10	0·00	0·2	0·15	0·0	0·00	0·1	0·05		0·15
CO	42·30	43·15	43·1	42·90	43·4	42·95	43·4	39·20		40·50
H_2	47·80	48·50	..	48·45	..	49·25	..	51·15		50·10
CH_4	1·20	1·30	..	1·40	..	0·85	..	0·85		0·70
N_2	5·35	3·90	..	4·15	..	3·40	..	3·20		4·05
..	100·00	100·00	..	100·00	..	100·00	..	100·00		100·00

It will be seen from these results that there was little change in the average composition of the water gas made during the first seven periods, when, with the exception of the 3½-minute up run immediately after each coking, normal up-down-up runs were made. When the runs were all in an upward direction, a larger proportion of carbon dioxide resulted, indicating a reduction in the temperature of the fuel bed. This lowering of temperature by steaming always in an upward direction is again brought out by a comparison of the results of analyses of average samples of the gas made during individual runs—given in Tables B and C.

TABLE B.—*Coking-to-Coking Period.*

	Up.	Up-down-up Runs.						
	3½ Mins.	4 Mins.	4 Mins.	4 Mins.	4 Mins.	4 Mins.	4 Mins.	4 Mins.
CO_2	2·70	2·45	3·3	2·90	3·5	3·35	3·5	3·50
C_mH_n	0·05	0·05	..	0·05	..	0·05	..	0·05
O_2	0·00	0·10	0·0	0·10	0·0	0·05	0·0	0·00
CO	42·85	43·60	43·2	43·35	43·5	43·25	43·2	43·65
H_2	50·80	49·50	..	48·85	..	48·65	..	48·10
CH_4	0·60	0·60	..	0·85	..	0·80	..	0·70
N_2	3·00	3·70	..	3·90	..	3·85	..	4·00
	100·00	100·00		100·00		100·00		100·00

The compositions of average samples taken during each run in a normal coking-to-coking period appear in Table B; and the compositions of samples taken during each of the up runs immediately before clinkering are given in Table C. It should be noted that the generator was charged and submitted to a 1½-minute blow immediately after the fourth sample in Table C.

TABLE C.

—	Up Runs Before Clinkering.							
	4 Mins.	4 Mins.	4 Mins.	4 Mins.	3½ Mins.	4 Mins.	4 Mins.	4 Mins.
CO_2	3·5	4·15	5·2	6·10	2·7	3·65	4·5	4·30
C_mH_n	..	0·05	..	0·05	..	0·05	..	0·05
O_2	0·0	0·05	0·1	0·00	0·0	0·05	0·0	0·10
CO	42·8	41·10	39·2	37·95	43·4	40·45	40·2	40·30
H_2	..	49·60	..	50·70	..	49·65	..	50·20
CH_4	..	0·35	..	0·60	..	0·55	..	0·65
N_2	..	4·70	..	4·60	..	5·60	..	4·40
		100·00		100·00	Generator charged.	100·00		100·00

From the analyses in Table B, it may be concluded that the heat generated during the 1½-minute blow preceding the first sample was sufficient to raise the fuel bed to a comparatively high temperature; for the first two samples contained only 2·7 p.ct. and 24·5 p.ct. of carbon dioxide respectively. The temperature then fell slightly, until a balance between the heat changes during the 1-minute blow and 4-minute run periods was attained; for the compositions of the last four samples were approximately the same. When, however, the steaming took place in an upward direction throughout (Table C), there was a progressive increase in the carbon dioxide content, until the generator was charged. As a result of the 1½-minute blow after coking, the amount of carbon dioxide in the fifth sample was only 2·7 p.ct., but again increased in subsequent samples. It therefore appears that less heat was taken up by the fuel bed during the 1-minute blows than was required in the steam-carbon reactions during the run periods, but that the resulting diminution of heat in the fuel bed was made up during the 1½-minute blow.

The preceding tables show the changes in composition that occurred from run to run. It remains to indicate the changes of composition which occurred during the individual runs. The results relating to a normal coking-to-coking period, consisting of one 3½-minute up run and seven 4-minute up-down-up runs are given in Table D. The 3½-minute up run was divided into four successive parts—(i.) 15 seconds, (ii.) 1½ minutes, (iii.) 1½ minutes, and (iv.) 15 seconds duration respectively. The first, fourth, and seventh of the 4-minute up-down-up runs were divided into their respective 1-minute up runs, 2½-minute down runs, and ½-minute up runs.

It will be observed from Table D that considerable amounts of nitrogen were present in the first samples of each individual run period. These high percentages of nitrogen were due to the method of operation of the valves; for in the change from blow to run, the stack-valve was closed before the blast-valve. That this method of operation accounted for the nitrogen above about 2 p.ct. in the final average composition of the water gas made, is clearly shown by a comparison of the nitrogen contents of the various samples during each run. The progressive increase in the amount of carbon dioxide in the water gas made as the run proceeded is well brought out by the analyses of all except the first samples of each period, which samples were vitiated by the presence of blow gas.

The progressive increase in the carbon dioxide content is also shown by the analyses (given in Table E) of samples resulting from a sub-division of a 4-minute up run before clinkering, and sub-divisions of a 1-minute up run, 2½-minute down run, and the last ½-minute up run of a normal 4-minute run.

THE PROPORTIONS OF STEAM DECOMPOSED AT DIFFERENT STAGES OF THE MANUFACTURE OF WATER GAS.

The proportions of steam decomposed at the different stages of manufacture were obtained from calculations of the water equivalents of the different compositions of gas made, and experiments carried out for the purpose of determining the amounts of undecomposed steam accompanying the water gas sampled at the inlet to the scrubber. The undecomposed steam in each experiment was determined by drawing a measured volume of gas through two weighed tubes, the first containing cotton wool and the second containing calcium chloride. The dust in the gas was allowed for by weighing the cotton wool tube immediately after the experiment, and again weighing after drying in an air oven

TABLE D.—*Normal Coking-to-Coking Period.*

—	3½ Min. Up Run after Coking.				1st Up-down-up Run.			4th Up-down-up Run.			7th Up-down-up Run.		
	15 Secs.	1½ Mins.	1½ Mins.	15 Secs.	1 Min. Up.	2½ Mins. Down.	½ Min. Up.	1 Min. Up.	2½ Mins. Down.	½ Min. Up.	1 Min. Up.	2½ Mins. Down.	½ Min. Up.
CO_2	2·70	1·90	2·95	4·05	2·00	2·45	4·85	2·5	3·3	6·8	2·95	3·25	6·25
C_mH_n	0·05	0·05	0·05	0·05	0·05	0·05	0·05	..	..	..	0·05	0·05	0·05
O_2	0·15	0·00	0·00	0·05	0·05	0·10	0·05	0·0	0·0	0·0	0·05	0·05	0·20
CO	43·70	46·00	43·05	41·45	43·65	44·30	42·60	43·1	43·0	40·8	44·10	42·25	40·20
H_2	25·30	49·45	52·25	52·00	43·50	50·95	49·65	..	..	..	42·05	51·80	50·55
CH_4	0·70	0·55	0·35	0·70	0·75	1·00	0·95	..	..	..	0·95	0·85	0·60
N_2	27·40	2·05	1·35	1·70	10·00	1·15	1·85	..	..	..	9·85	1·75	2·15
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	..	..	..	100·00	100·00	100·00

TABLE E.

—	Normal Up-down-up Run.								Last 4 Min. Up Run Before Clinkering.			
	1 Min. Up Run.			2½ Mins. Down Run.			½ Min. Up Run.					
	15 Secs.	28 Secs.	18 Secs.	15 Secs.	1 Min. 55 Secs.	20 Secs.	15 Secs.	18 Secs.	15 Secs.	1½ Min.	1 Min. 55 Secs.	20 Secs.
CO_2	3·70	1·95	2·35	2·20	2·75	3·80	5·70	6·55	3·95	2·25	6·70	8·80
C_mH_n	0·05	0·05	0·05	0·05	0·05	0·05	0·05	0·05	0·05	0·05	0·05	0·05
O_2	0·00	0·25	0·05	0·35	0·00	0·20	0·20	0·00	0·10	0·20	0·25	0·10
CO	40·70	48·15	45·80	45·30	43·80	42·40	42·15	40·85	41·45	45·25	37·55	33·95
H_2	18·10	46·30	49·35	48·10	51·80	51·55	48·45	50·35	16·40	49·30	52·80	54·45
CH_4	0·45	0·40	0·75	0·50	0·40	0·35	1·05	0·75	0·80	0·60	0·95	0·80
N_2	37·00	2·90	1·65	3·50	1·20	1·65	2·40	1·45	37·25	2·35	1·70	1·85
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

at 105° C. The following determinations of the amounts of undecomposed steam were made:

(*a*) Two determinations during a normal 41-minute coking-to-coking period—(i.) an average of the first 3½-minute up-run and (ii.) an average of the following seven normal up-down-up runs.

(*b*) Three determinations during the seven 4-minute up runs of a normal 41-minute coking-to-coking period—(i.) an average of the 1-minute up runs, (ii.) an average of the 2½-minute down runs, and (iii.) an average of the ½-minute up runs.

(*c*) Two determinations during the up runs before clinkering—(i.) an average over the four 4-minute up runs before coking, and (ii.) an average over the four 4-minute up runs between coking and clinkering, and

(*d*) Three determinations during the eight up runs before clinkering—(i.) an average of the first minute of the eight runs, (ii.) an average of the middle two minutes, and (iii.) an average of the last minute.

The results of experiments (*a*) and (*b*) are given in Table F, and (*c*) and (*d*) in Table G, both of which tables also include the water equivalent of the gas made and the percentage of steam decomposed.

From the figures given in the two tables for the percentage of steam decomposed, the calculated proportions of steam converted into water gas during a complete clinker-to-clinker period is approximately 70 p.ct., which amount is in good agreement with the average of the results of the three tests given in the water balances (Table V.). The results show the decrease in the proportion of steam decomposed as each run proceeds—*i.e.*, as the temperature of the fuel bed is lowered. It should be noted that the low efficiency of 41 p.ct. given in Table F for the last ½ minute of a normal up-down-up run is due, not merely to the low temperature of the fuel bed, but also to the fact that, in changing from down steaming to up steaming, the space in the generator above the fuel bed was occupied by steam which was swept away with the water gas made during the last ½ minute without having passed through the incandescent fuel; and this latter influence would be considerable in a run of short duration.

THE PROPORTION OF SULPHURETTED HYDROGEN IN WATER GAS AT DIFFERENT STAGES OF MANUFACTURE.

The changes in the amounts of sulphuretted hydrogen in the water gas made at different stages of the process from one clinkering to the next were determined by a systematic investigation of samples taken at the scrubber inlet. In the first instance, nine determinations were made during a complete clinker-to-clinker period, divided as follows:

(*a*) Six determinations representing averages of successive coking-to-coking periods, each comprising one 3½-minute up run and seven normal 4-minute up-down-up runs.

(*b*) One 21-minute period, comprising one 3½-minute up run and three 4-minute up-down-up runs.

(*c*) One 20-minute period, including four 4-minute up runs.

(*d*) One 26-minute period, including one 3½-minute up run and four 4-minute up runs.

The results of these determinations appear in Table H, from which it may be observed that the sulphuretted hydrogen content of the gas made during the normal coking-to-coking periods was approximately constant at about 230 grains per 100 c.ft., but that

TABLE F.—*Water in Lbs. per* 1000 *C.Ft. Water Gas at* 60° *Fahr. and* 30 *In. Moist.*

—	(*a*) One Normal 41-Minute Coking-to-Coking Period.		(*b*) Seven 4-Minute Up-down-up Runs of a Normal 41-Minute Period.		
	The 1st 3½-Minute Up Run.	Seven 4-Minute Up-down-up Runs.	1-Minute Up Runs.	2½-Minute Down Runs.	½-Minute Up Runs.
Water equivalent of water gas	24·4	23·6	20·9	25·0	24·3
Undecomposed steam	10·1	9·8	3·3	8·8	34·8
Steam decomposed per cent.	71	71	86	74	41

TABLE G.—*Water in Lbs. per* 1000 *C.Ft. Water Gas at* 60° *Fahr. and* 30 *In. Moist.*

—	(*c*) Eight 4-Minute Up Runs Before Clinkering.		(*d*) Eight 4-Minute Up Runs Before Clinkering.		
	Four Runs Before Coking.	Four Runs After Coking.	First 1 Minute of Up Runs.	Middle 2 Minutes of Up Runs.	Last 1 Minute of Up Runs.
Water equivalent of water gas	23·9	23·8	19 9	25·0	25·9
Undecomposed steam	13·8	14·7	10·6	14·2	21 8
Steam decomposed per cent.	63	62	65	64	54

TABLE H.—*Sulphuretted Hydrogen in Grains per 100 C.Ft. of Water Gas.*

(a) Normal Coking-to-Coking Periods.						(b)	(c) Up Runs.	(d) Up Runs.
41 Mins.	41 Mins.	41 Mins.	41 Mins.	41 Mins.	41 Mins.	21 Mins.	20 Mins.	26 Mins.
214	230	220	252	226	225	259	419	372

TABLE J.—*Sulphuretted Hydrogen in Grains per 100 C.Ft. of Water Gas.*

Normal Coking-to-Coking Periods.

3½ Mins. Up Run.	Up-down-up Runs.						
	4 Mins.	4 Mins.	4 Mins.	4 Mins.	4 Mins.	4 Mins.	4 Mins.
368	231	229	249	239	239	227	257

Up Runs before Clinkering.

4 Mins.	4 Mins.	4 Mins.	3½ Mins.	4 Mins.	4 Mins.	4 Mins.	4 Mins.
444	446	461	401	426	455	418	473

the gas made during the period of up runs contained the much larger amount of about 400 grains per 100 c.ft.

The greater proportion of sulphuretted hydrogen made during the up runs is further brought out in Table J, which gives the results of determinations of average samples of the gas made during the individual runs of a normal coking-to-coking period, and during the up runs before clinkering.

The results obtained by the fractionation of the following individual runs appear in Table K:

(*a*) A normal 4-minute run into its up steaming and down steaming sections.

(*b*) The 2½-minute down run section of a normal 4-minute run into three parts of ½ minute, 1 minute, and 1 minute duration respectively.

(*c*) A 4-minute up run before clinkering into fractions of 1 minute, 2 minutes, and 1 minute.

Table L gives the results obtained by the sub-division of a 3½-minute up run immediately after coking into fractions of 1 minute, 1½ minutes, and 1 minute, and of a normal run immediately after clinkering but before coking into its up steaming and down steaming sections.

The larger sulphuretted hydrogen content of the gas made in the up runs is again revealed in the results given in these two tables. The figures obtained by the fractionation of the 2½-minute down run and 4-minute up run [(*b*) and (*c*) Table K] lead to the conclusion that during steaming in a given direction the amount of sulphuretted hydrogen in the gas increases as the run proceeds—*i.e.*, as the temperature of the fuel bed falls. The results obtained, however, by the fractionation of a 3½-minute up run after coking (Table L) do not increase from the first to the third fraction, for the first fraction contained more sulphuretted hydrogen than the second and third. The conditions prevailing during the 4-minute up-down-up run immediately after clinkering and before coking were different from those at any other stage of the process; for the ashes and clinker had just been removed, and the fuel bed was abnormally low.

THE COMPOSITIONS OF BLOW GAS AT DIFFERENT STAGES OF OPERATION OF A WATER-GAS GENERATOR.

A knowledge of the compositions of the blow gas produced at the different stages is essential in a complete study of the changes occurring in a particular cycle of operations of a water-gas plant. A systematic investigation of the compositions of the blow gas was therefore carried out. In the first series of experiments, average samples of the blow gas produced during the following sections of a complete clinker-to-clinker period were taken:

(*a*) Six samples representing six separate and successive normal coking-to-coking periods.

(*b*) The succeeding 21-minute period, which included one 3½-minute up run and three 4-minute up-down-up runs.

(*c*) The period before clinkering when steaming was adopted in an upward direction only.

The results of analyses of these samples are set out in Table M, which also includes the air pressures in inches of water at the outlet of the blower.

It will be seen from this table that the percentages of carbon dioxide in the blow gas produced during the six normal coking-to-coking periods gradually decreased from 13 to 10·9 p.ct., while there was a corresponding increase in the carbon monoxide from 11·95 to 16·15 p.ct. This change was continued into the following 26-minute period, when, with the exception of the first run after coking, normal up-down-up runs were adopted. Since the average composition of the water gas during similar coking-to-coking periods remained approximately constant, it would appear that

TABLE K.—*Sulphuretted Hydrogen in Grains per 100 C.Ft. of Water Gas.*

(a) Normal 4-Minute Up-down-up Run.			(b) 2½-Minute Down Run of Normal Run.			(c) 4-Minute Up Run Before Clinkering.		
1 Min. Up.	2½ Min. Down.	½ Min. Up.	½ Min.	1 Min.	1 Min.	1 Min.	2 Min.	1 Min.
319	201	242	179	205	257	272	384	574

TABLE L.—*Sulphuretted Hydrogen in Grains per 100 C.Ft. of Water Gas.*

3½-Minute Up Run After Coking.			4-Minute Up-down-up Run Immediately After Clinkering.		
1 Min.	1½ Min.	1 Min.	1 Min. Up.	2½ Min. Down.	½ Min. Up.
466	377	438	522	239	347

TABLE M.

—	(a) Coking-to-Coking Periods.						(b)	(c)
	36 Mins.	41 Mins.	41 Mins.	41 Mins.	41 Mins.	41 Mins.	26 Mins.	Up Runs 36 Mins.
CO_2	13·00	11·7	11·6	11·4	11·3	10·90	10·0	12·00
O_2	0·35	0·0	0·1	0·1	0·2	0·20	0·1	0·30
CO	11·95	14·2	14·4	14·6	14·6	16·15	17·5	13·60
H_2	3·30	..	..	..	..	3·35	..	3·45
CH_4	0·35	..	..	..	..	0·20	..	0·40
N_2	71·05	..	..	..	..	69·20	..	70·25
	100·00	..	..	..	..	100·00	..	100·00
Air pressure, inches water.	13	14	13½	14½	14½	15½	15½	15½

TABLE N.—*Normal 41-Minute Coking-to-Coking Period. Air Pressure = 14 ins.*

Duration of Blow.	1½ Mins.	1 Min.	1 Min.	1 Min.	1 Min.	1 Min.	1 Min.	1 Min.
CO_2	9·85	10·6	11·35	11·4	11·4	11·30	11·4	11·25
O_2	0·10	0·0	0·05	0·1	0·0	0·00	0·1	0·05
CO	17·40	15·3	14·50	14·4	14·2	14 95	14·3	15·60
H_2	1·75	..	2·15	..	..	2·85	..	3·45
CH_4	0·90	..	0·70	..	..	0·80	..	0·65
N_2	70·00	..	71·25	..	..	70·10	..	69·00
	100·00	..	100·00	..	..	100·00	..	100·00

TABLE P.—*Up Run Period before Clinkering. Air Pressure = 15 ins.*

Duration of Blow.	1 Min.	1 Min.	1 Min.	1 Min.	1½ Mins.	1 Min.	1 Min.	1 Min.
CO_2	11·15	12·3	12·9	13·30	10·65	11 9	12·5	13·30
O_2	0·05	0·1	0·1	0·00	0·35	0·1	0 1	0·25
CO	15·90	14·0	12·8	12·50	15 75	14·1	12 6	11·85
H_2	1·15	..	..	4·35	2·80	..	..	4·45
CH_4	0·90	..	..	0·35	0·35	..	..	0·30
N_2	70·85	..	..	69·50	70·10	..	..	69 85
	100·00	..	..	100·00	100·00	..	..	100·00

the gradual change in the composition of the blow gas was due to the gradual reduction in the rate of delivery of air to the generator, as shown by the increase in pressure at the outlet of the blower.

The reduction in the rate of delivery of air was caused by an increase in the resistance of the fuel bed which must have resulted from the accumulation of clinker. In the last sample of the series, when steaming was carried out in an upward direction only, the carbon dioxide content reached the higher figure of 12 p.ct.—thus confirming the conclusions already drawn from the analyses of the water gas made during this stage.

The comparative effects of normal up-down-up runs and runs in the upward direction only are further emphasized by the analyses in Tables N and P, which give the average compositions of the blow gas produced during each blow of a normal coking-to-coking period, and during each blow of the period of up runs before clinkering.

The almost constant amount of carbon dioxide in the gas produced during the six blow periods in Table N shows a marked contrast with the increasing amounts of carbon dioxide in the first four and second four samples in Table P. The effect of the 1½-minute blow after coking is clearly shown by the lower percentages of carbon dioxide in the first sample in Table N and the fifth in Table P.

Experiments were also carried out for the purpose of determining the changes in composition of the gas produced during individual blow periods. The composition of the gas passing up the stack during the first 15 seconds was not considered to be of importance, since it would contain a certain proportion of water gas swept out from the generator after the steam had been cut off and the stack valve opened. Three samples were taken during each blow period examined; the first commencing 15 seconds after the opening of the stack valve, the third 10 seconds before the stack valve was closed, and the second midway between the other two. The time occupied in collecting each sample was about 7 seconds. Four individual blows were fractionated in this manner.

(*a*) A 1-minute blow during a normal coking-to-coking period.
(*b*) A 1½-minute blow after coking.
(*c*) A 1-minute blow during the up run period before clinkering.
(*d*) The 1-minute blow immediately after clinkering and before coking.

The results obtained are set out in Tables R and S.

TABLE R.

	(*a*) 1-Minute Blow during Normal Coking-to-Coking Period.			(*b*) 1½-Minute Blow after Coking.		
Sample No.	No. 1.	No. 2.	No. 3.	No. 1.	No. 2.	No. 3.
CO_2	14·05	12·75	10·95	14·35	10·05	8·05
O_2	0·35	0·05	0·15	0·05	0 45	0 20
CO	9·75	12·35	15·50	9·80	16·80	20·25
H_2	1·60	1·55	1·25	0·55	1·50	1·40
CH_4	0·45	0·65	0·85	0·40	0·45	0·85
N_2	73·80	72·65	71·30	74·85	70·75	69·25
	100·00	100·00	100·00	100·00	100·00	100·00

It is interesting to compare the low carbon monoxide content of 6·15 p.ct. in the first sample of a 1-minute blow in the period before clinkering with the value of 9·75 p.ct. in the first sample of a 1-minute blow during a normal coking-to-coking period. The effect of the 1½-minute blow immediately after coking is shown in the high proportion of 20·25 p.ct. of carbon monoxide attained in the third sample as compared with 15·5 p.ct. in the third sample of the normal 1-minute blow. The small quantity of carbon monoxide (2·4 p.ct.) in the first sample of the 1-minute blow immediately after clinkering was due to the heat lost during the clinkering period, combined with the lower fuel depth of about 5 ft. at this stage.

TABLE S.

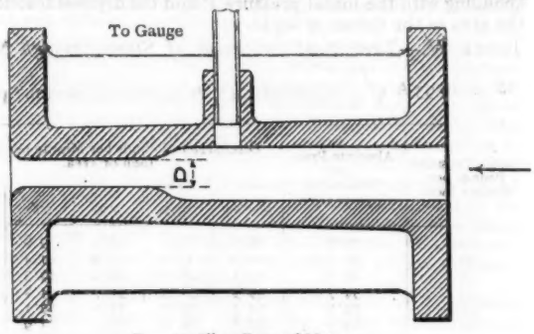
	(*c*) 1-Minute Blow in Up-Run Period before Clinkering.			(*d*) 1-Minute Blow immediately after Clinkering.		
Sample No.	No. 1.	No 2.	No. 3.	No. 1.	No. 2.	No. 3.
CO_2	16·45	14·65	12·60	18·40	16·20	14·35
O_2	0·10	0·30	0·25	0·25	0·20	0·30
CO	6 15	9 65	13·35	2 40	6·10	9·35
H_2	2·30	1 95	1·90	0·60	0·95	1·50
CH_4	0·25	0·30	0·40	0·35	0 40	0·30
N_2	74·75	73 15	71·50	78·00	76 15	74·20
	100·00	100·00	100·00	100·00	100·00	100·00

In general, the compositions of the blow gases given in Tables M to S confirm the conclusions drawn from the composition of the run gas in Tables A to E.

SECTION III.

CALCULATION OF THE STEAM SUPPLY TO GENERATOR.

The water-gas generator was equipped with steam-meters of the type shown in section in Diagram IV., which meters were



D = ·746″ at Base of Meter
D = ·708″ ,, Top ,, ,,

DIAGRAM IV.—Section of Steam-Meter Nozzle.

fitted with gauges calibrated to indicate rates of steam flow in lbs. per minute. These gauges had been in use since the plant was installed, so that it was probable that the flows indicated by them would be unreliable. Direct calibration of the nozzles at different pressures of steam by condensation, as adopted with the comparatively small nozzles used in the Uddingston tests, was impracticable, owing to the large amount of cooling water which would have been required. The alternative method, which was adopted, was to calculate the rates of flow from the areas of the throats and the pressures of steam at the inlet to the nozzles by substitution in a recognized formula. The throat areas were obtained by accurate measurements of the diameters by means of internal calipers and a micrometer gauge; and the pressures were read off on calibrated Bourdon gauges specially installed.

From theoretical considerations, it may be deduced that, subject to certain conditions, the flow of steam through a nozzle is represented by the following expression:

$$W = KA\sqrt{\frac{P}{V}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

in which W is the discharge of steam in lbs. per minute, A the cross-sectional area in square inches of the throat of the nozzle, P the initial steam pressure (absolute) in lbs. per sq. in., V the volume in cubic feet of 1 lb. of steam at pressure P, and K a constant depending on the state of the steam—whether superheated, dry-saturated, or wet. The following conditions are to be fulfilled in the application of this expression:

(*a*) The friction losses in the nozzle should be as small as possible, to minimize the loss of kinetic energy by conversion into heat energy. These friction losses are reduced to negligible amounts in nozzles of correct design.

(*b*) The absolute pressure of steam at the outlet of the nozzle should not be greater than rP, in which r possesses a value varying under ordinary conditions between 0·5 and 0·6, according to the state of the steam. In the case of superheated steam, r has the value of 0·5457; so that the rate of discharge of superheated steam through a nozzle of correct design is given at any initial pressure by expression (1), provided that the absolute pressure at the outlet of the nozzle is not greater than 0·5457 P.*

In the case of superheated steam, K has the value of 18·93. If the steam be dry-saturated or wet, the value of K is dependent on the value of the dryness fraction x, provided the condensation of the steam keeps pace with that required to correspond with the expansion in volume at the nozzle. It is well known that water vapour can be obtained in a saturated condition—*i.e.*, expansion can occur without condensation having taken place. In a nozzle, however, the condensation in the throat itself will be inappreciable, since the time required for the steam to reach the throat, and the difference between the density of saturated steam and steam in which no condensation has taken place, are both small. Callendar ("Properties of Steam," 1920) adopts this view, and therefore assumes that no condensation occurs until after the steam has passed the throat of the nozzle; so that the value of K for dry-saturated or wet steam in expression (1) will be the same as that for dry steam. The expression therefore becomes

$$W = 18{\cdot}93\,A\sqrt{\frac{P}{V}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

In the case of superheated and dry-saturated steam, the volume V may be taken directly from steam tables; but if the steam be initially wet,

$$V = V_s - (1 - x)(V_s - V_w)$$

in which V_s is the volume per lb. of dry-saturated steam at pressure P, V_w is the volume per lb. of water, and x is the dryness fraction. With pressures below 100 lbs. per sq. in. it is sufficiently accurate to consider that $V = xV_s$. In making calculations from expression (2), it must be remembered that P is the *absolute* pressure—*i.e.*, the gauge pressure, *plus* 14·7.

The rates of discharge of steam in lbs. per sq. in. of throat area of the nozzle for values of the dryness fraction from unity to 0·8, as calculated from expression (2), are given in Table W. To obtain from this table the theoretical rate of discharge of steam for a given nozzle, it is necessary to multiply the discharge corresponding with the initial pressure P and the dryness fraction x by the area of the throat in sq. in.

TABLE W.—*Theoretical Discharge of Steam through Nozzles.*

$W = 18{\cdot}93\,A\sqrt{\frac{P}{V}}$ (Callendar's "Properties of Steam," p. 237).

Gauge Pressure Pounds per Square Inch.	Absolute Pressure Pounds per Square Inch.	Discharge in Pounds per Minute per Square Inch of Area.				
		$x = 1{\cdot}0$	0·95	0·90	0·85	0·80
25	39·7	36·5	37·4	38·5	39·6	40·8
30	44·7	40·9	42·0	43·2	44·4	45 8
35	49·7	45·4	46·7	48·0	49·3	50·9
40	54·7	49·9	51·3	52·7	54·2	55·9
45	59·7	54·4	55·9	57·4	59·1	60·9
50	64·7	58·8	60·4	62·1	63·9	65·8
55	69·7	63·2	64·9	66·7	68·6	70·7
60	74·7	67·6	69·4	71·3	73·4	75·6
65	79·7	72·0	73·9	76·0	78·1	80·5
70	84·7	76·4	78·4	80·6	82·9	85·4

Experiments have proved that the actual discharges of steam in lbs. per minute through nozzles are given by

Actual discharge = $k \times$ theoretical discharge,

where k is a discharge coefficient dependent on the design of the nozzle. The recent experiments of Mellanby and Kerr ("Engineering," March 4, 1921, p. 273) give results for a nozzle of the convergent-parallel type used in the steam-meters of the water-gas plant at Adderley Street, from which it is concluded that the value of the discharge coefficient for steam with medium superheat is approximately 0·93. This value 0·93 has therefore been used in conjunction with Table W and the known throat areas, for the purpose of calculating the rate of flow of steam into the generator during the tests described in this report. The throat areas were 0·4369 sq. in. for steam admitted during the up runs and 0·3936 sq. in. during the down runs. The lengths of time during which steam was admitted to the generator were computed from the gas-making records; due allowance being made for the time lost in manipulating the control levers and in regulating the steam-valves. On the assumption that the dryness fraction of the steam used was 0·95, the following figures have been obtained for the amounts of steam passed into the generator per 1000 c.ft. of water gas made. They are compared with the values calculated from the compositions of the water gas and the amounts of undecomposed steam as given in the water balances (Table V.).

Steam to Generator in Pounds per 1000 c.ft. Water Gas.

Test No.	1	2	3
From calibration of steam-meters . .	32·6	30·9	34·4
From water balances (Table V.) . .	33·3	32·2	35·2

Very satisfactory agreement is to be observed in the results obtained by the two methods of calculation. The figures given in the water balances, and which are not based on any assumed values of the dryness fraction of the steam and the coefficient of discharge of the nozzles, may therefore be accepted with confidence.

CALIBRATION OF THE ROTARY METER.

The rotary meter was calibrated usually over a period of two hours at such times that the atmospheric conditions remained almost constant. The rate of flow of gas out of the holder for some time before the calibration was so adjusted that the relief holder contained approximately 70,000 c.ft. of gas. The gas-making plant was then shut-down, and the valves between the plant and the holder were closed. The rate of flow of gas through the meter during the period of calibration was adjusted to 25,000 c.ft. per hour, which was the approximate rate of flow during the complete tests. Half-hourly meter readings were taken; and at the same time measurements were made of the height of the holder, the capacities of which in all positions had been obtained by previous measurements of the circumference, crown, and thickness of the plates. The temperature of the gas in the holder was determined every half-hour from readings of thermometers placed in a number of positions on the top and round the sides of the holder and in the water tank. The temperatures and pressures in the meter and pressures in the holder were also taken. Repeat calibrations gave results in agreement within 1 p.ct.

METHODS OF ANALYSIS.

The methods of analysis adopted were generally the same as those described in detail in Appendix II. of the fourth report of the Gas Investigation Committee.*

An improvement in the peroxide method of determination of sulphur in coke was made by carrying out the combustion in a special steel bomb, which is a modification of the pattern used in the Department of Fuel of the University of Leeds, and described by Mr. H. J. Hodsman to the Yorkshire section of the Society of Chemical Industry in January this year. The bomb, which is shown in section in Diagram V., contains an elongated steel crucible 4 in. long and 1 in. diameter, closed with a loose-fitting lid with a perfectly flat rim, which rests on the flat top edge of the crucible. The crucible and lid are placed in an outer steel tube with a screw-down cover. A shoulder inside the cover is so made that, when the cover is screwed down, the lid of the crucible is held firmly in position. A mixture of 1 gram of coke and 15 grams of peroxide is placed inside the crucible, and covered with a layer of 2 grams of peroxide. The crucible is then placed inside the outer case, and the whole heated in the flame of a Méker burner for about twenty minutes. The bomb is then cooled, and the reaction mixture extracted with water and treated for the precipitation of sulphur as described in the Fourth Report. As a result of a large number of experiments, it has been found that the method serves equally well for tar and coal. It should be noted that sodium peroxide usually contains a certain amount of sulphur and that the amount may vary considerably in different portions of the samples procurable. It is therefore necessary thoroughly to mix sufficient peroxide for a number of determinations of sulphur and to carry out blank determinations on the mixed peroxide.

DIAGRAM V.—Combustion Bomb for Sulphur.

* See "JOURNAL," Vol. CL., p. 604.

* When dry-saturated or wet steam is passed through a nozzle of correct design, a proportion of the total heat of the steam is accounted for by conversion into kinetic energy and by the work of expansion, with the result that condensation takes place. When "wire-drawing" occurs, however, some of this kinetic energy is converted back into heat energy by friction; and under certain conditions, sufficient heat is recovered in this way to increase the dryness fraction of the steam.

The Albert Medal of the Royal Society of Arts for 1921 has been awarded by the Council, with the approval of the President, H.R.H. the Duke of Connaught and Strathearn, K.G., to Prof. John Ambrose Fleming, M.A., D.Sc., F.R.S., in recognition of his valuable contributions to electrical science and its applications, and especially of his original invention of the thermionic valve.

FIFTH REPORT OF THE RESEARCH SUB-COMMITTEE OF THE GAS INVESTIGATION COMMITTEE OF THE INSTITUTION OF GAS ENGINEERS.

THE SIMMANCE RECORDING CALORIMETER.

WE give to-day the first portion of the Fifth Report of the Research Sub-Committee of the Gas Investigation Committee, which was prepared for the meeting of the Institution of Gas Engineers. The names of the Committee and the introductory sentences will be found in connection with the Sixth Report, on p. 619 of the "JOURNAL" for June 15. It was there stated that in the Fifth Report the results are embodied of an investigation undertaken primarily by the invitation of the Recording Calorimeters Sub-Committee of the Institution into the accuracy and general reliability under working conditions of recording calorimeters, and particularly of the Simmance recording calorimeter. For this purpose, numerous and carefully chosen experiments and calculations have been necessary; and the Committee have never had greater reason to thank Mr. James W. Wood, the Research Chemist, who has been immediately responsible for the work.

PART I.

The passing of the Gas Regulation Act of 1920, and the embodiment therein of the new principle of evaluating gas for selling purposes by the potential heat units it carries, have placed the gas calorimeter in a position of predominating importance. Legal and commercial considerations both point to the desirability of securing complete and continuous information as to the calorific value of the gas which an undertaking supplies; and it is natural to look to the recording calorimeter for this purpose. It is equally natural that the gas industry should desire to know much more exactly than before of what accuracy this instrument is capable under the various conditions of service. The Research Sub-Committee were requested to undertake this inquiry, and commenced their work on the Simmance recorder.

This instrument had received the commendation of Sir George Beilby, and has since that time been under examination by Prof. Gray and Mr. Blackie, of the Fuel Research Board, who have reported favourably upon it. The calorimeter had evidently been designed with both care and ingenuity; and though strict examination has disclosed some imperfections, it must not be forgotten that the design of a recording calorimeter offers difficulties which are very great, and may prove insuperable. The various sources of error to which a recording calorimeter of this type is liable were examined in a detail which we believed the new importance of the subject to justify; and the report is made in the same detail, in order that the industry may know the nature and extent of the difficulties encountered by the designers and users of any instrument of which so much is demanded.

Brief comment will be found on certain points which arise in connection with the instruments of another type, of which the Beasley is an example.

PRELIMINARY CONSIDERATIONS.

It may be advisable at the outset to detail some of the considerations which have influenced our choice of methods for the testing of recording calorimeters. To be of real service, such instruments will be expected to run continuously for considerable periods. Tests of durability or "useful life" must therefore be an essential feature of the examination; and the accuracy of the instruments, both when new and after being subjected to reasonable wear and tear, also requires examination. Testing over a considerable period of time is clearly necessary; and three months is suggested as a minimum time in which a reliable opinion can be formed. The tests detailed in this report extended over a period of some nine months, during which time the instruments were in continuous operation.

Perhaps the simplest method of testing, and the one which, possibly, would be adopted by most undertakings, would be to set up the instrument in accordance with the instructions supplied; to connect it to a convenient gas supply; and then at suitable intervals, governed by the staff and amount of time available for the purpose, to make actual determinations of the calorific value of the gas. These would be compared with the values shown on the chart, and a note made of the maximum, minimum, and average differences, upon which data an estimate would be formed as to the reliability of the recorder. This will, in fact, be the final method of testing for any recorder.

It is, however, open to criticism in several directions. Only the agreement between the charted C.V. and that determined by direct observation is checked by this method. The accuracy of the latter, especially when a new type of water-flow calorimeter is incorporated with the recorder, may itself be in question. Comparison with an accepted pattern of water-flow calorimeter is clearly necessary, in addition to comparisons between the continuous record and the separate determinations on the instrument in question.

In general, the record obtained under the foregoing conditions will not be indicating a constant C.V.; and it will be difficult to differentiate between the effects produced by irregularities of the recorder and those due to real variations in gas quality. This uncertainty can be eliminated if a holder is available of sufficient capacity to supply the recorder with gas of constant C.V. for lengthy periods. Use may also be made simultaneously of a recorder—such as a specific gravity recorder—depending upon some other property of the gas, for detecting changes in gas quality. Where the accuracy of a recorder is dependent to some extent upon atmospheric temperature and pressure, and upon the nature of the gas supplied to it, it is important that the instrument should be tested over a sufficiently wide range of conditions, so that the results obtained may be directly applicable to most conditions likely to be met with in practice. On this account, results obtained in well-controlled testing-stations, supplied with the comparatively uniform gas of large undertakings, may be considerably better than those obtained elsewhere in less favourable circumstances. It is, however, the behaviour of the recorder under fluctuating conditions of supply which may become of vital importance in certain cases. The range of conditions examined in this report has been such as to cover all those cases likely to be met with in town's gas practice; and the limits will be defined in due course.

The method of testing now under discussion shows the combined influence of all factors upon the difference between charted and determined C.V. If faults should be found with the record, little information is provided for locating faults, apportioning blame to different parts of the apparatus, or suggesting lines upon which improvement might be sought with the greatest promise of success. Our experience in the early part of the investigation pointed to the necessity for a detailed examination of all component parts of the recorders and their effects upon the charted C.V.; and prominence has been given to this treatment of the instruments in the present report.

It would seem that the degree of accuracy obtainable with a recording calorimeter depends to a considerable extent upon the amount of supervision it can receive. Slight errors of no particular consequence may, if accumulative, produce in 24 hours a total error in a week or month which may be anything but negligible. The frequency with which the instrument requires adjustment is important; and if this is done daily or after each direct determination of C.V., the examination resolves itself into a test of reliability over short periods only. Valuable as this may be, a wrong estimate might be formed as to the capabilities of the instrument, run without attention for longer periods. In the present investigation, the instruments have been allowed to run continuously, and the errors have been noted, but no adjustment made, until the errors have become so large as to stultify the readings. In actual practice, such adjustment would be made as soon as the accumulated error exceeded (say) 5 p.ct. For smaller errors than this, application of corrections to the chart is preferable to frequent readjustment of the mechanism. The particular methods for testing, and the detailed examination of all component parts of the recorders, have been adopted in an attempt to meet some of the foregoing criticisms, and to place the investigation upon a thoroughly scientific basis, at the same time providing material upon which an improved design of calorimeter might be based, if necessary.

In framing the report, a considerable amount of descriptive matter has been inserted to render the report self-contained. Matters of importance in connection with the theory of the recorder, and accounts of supplementary tests in connection with their mechanism, have been relegated to Appendix I., in order to simplify and shorten the main report.

TESTING LABORATORY.

Facilities for testing were kindly placed at our disposal by the City of Birmingham Gas Department; and a room was set apart at the Central Laboratory exclusively for calorimeter testing.

The holder is of sufficient capacity to supply two recorders and either a Junkers or Boys calorimeter for 24 hours. The Junkers and Boys instruments have been used as comparison instruments alternately; and occasionally simultaneous tests have been executed showing satisfactory agreement between the two. If necessary, a continuous test of 60 hours' duration can be made on a single recorder with gas of constant C.V. The holder is usually filled, and allowed 12 to 16 hours for its contents to become uniform by diffusion. Matters can be hastened by mechanical stirring.

During the time the holder is not available, gas is taken from the town supply; and it is not necessary to extinguish the calorimeter burner when changing-over the supply. While tests are in progress, a steady stream of gas is maintained through the test service by connecting a cock to the open air, to the exhauster service, or to a burner. The uniformity of the gas and need for its

conservation rendered this precaution unnecessary when working from the holder. The holder could be filled with almost any grade of gas, from Mond gas to high-grade coal gas. Blue water gas and blue water gas mixtures were available, and other synthetic mixtures readily prepared. This has enabled tests to be carried out in one laboratory, without disturbing any of the appliances, over a range covering all commercial requirements as regards gas quality.

At the outset, the calorimeters were received from their respective makers and set up and worked according to instructions. No attempt at correction of the makers' adjustments was made; but attention was concentrated upon getting a chart showing a close approximation to a straight line from a gas of constant calorific value. When this could not be successfully achieved, a close examination of all the component parts of the instruments was made. Special tests and experimental methods were devised to test the accuracy or otherwise of their adjustment, and sources of error located as far as possible. When the most satisfactory adjustment of mechanism had been obtained, and the necessary precautions in use determined, a fresh series of tests was started. Under the new conditions, the adjusted instrument received an amount of attention which might be considered reasonable for some of the medium and larger sized undertakings. An improved result was obtained, as will be indicated later. When carrying out the tests, it was not known what limits of accuracy in the recorder would finally be accepted as satisfactory. All measurements used in comparisons were therefore made to an accuracy within at least 0·5 p.ct., and all known causes likely to affect the record to a similar extent have received consideration.

The Simmance Total-Heat Recorder—General Statement.

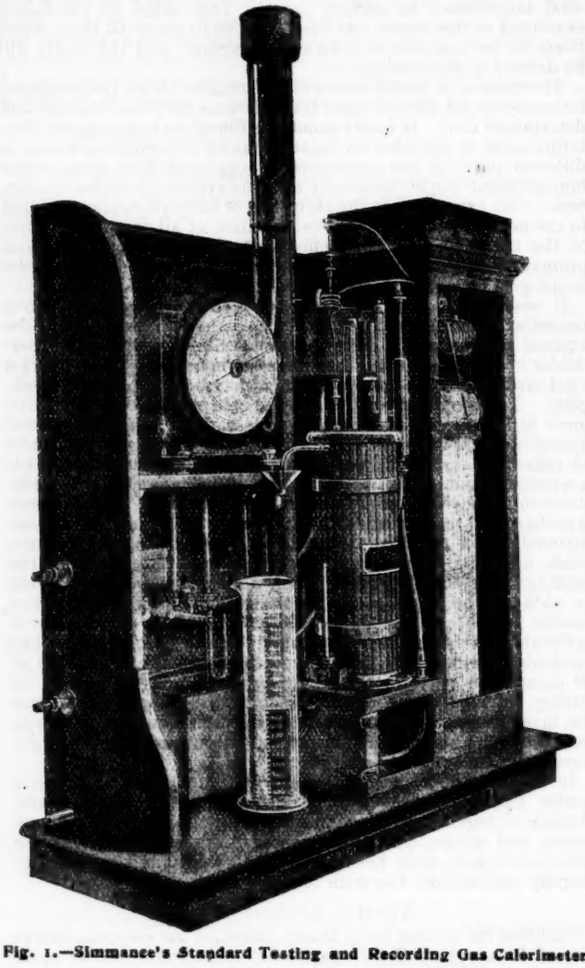


Fig. 1.—Simmance's Standard Testing and Recording Gas Calorimeter.

The calorimeter to which attention has been principally devoted is the "Total-Heat Recording Calorimeter" invented by Mr. John F. Simmance, and fully described in the "Gas Journal" for Oct. 16, 1917 (p. 118), and in a subsequent reprint of the article issued by Messrs. Alex. Wright & Co., of Westminster. The apparatus is self-contained, and comprises a water-flow calorimeter combined with mechanism for continuously recording the C.V. of the gas upon the chart. The gas rate is controlled in a unique manner; and within limits the record indicates directly the calorific value of the gas reduced to standard conditions—viz., 60° Fahr. and 30 in. bar., independently of changes in atmospheric temperature and pressure, or of changes in specific gravity of the gas. As far as possible, the instrument has been rendered automatic in its action, but nevertheless possesses the merit that an independent check test can be made at any instant without interrupting the continuity of the record. The instrument thus possesses novel features; and it was clearly desirable to examine its behaviour when subjected to prolonged testing on gases of different qualities, under practical conditions of use, with a view to determining the limits of its accuracy. While our investigation has been in progress, the makers also have been experimenting independently and collecting evidence as to the behaviour of instruments supplied to their clients in various parts of the country. This has led to a number of valuable improvements in design, to overcome specific difficulties; and such of these improvements as have been notified to us by Mr. Simmance are summarized in Appendix II.

It is proposed to follow through (in turn) the instrument, the gas, water, air, and products of combustion; to consider the accuracy with which each is controlled; and, finally, to summarize their combined effects upon the recorded calorific value.

Course of Gas Through Calorimeters.

Preliminary Governing.—Inasmuch as the test service was also supplying instruments other than the recorder, and gas supplies were drawn from different sources, at pressures ranging from 25-10ths to 12 in. water gauge, a mercury governor was installed at the inlet to the test service and set to reduce the pressure to 25 10ths.

Dry Governors.—The gas enters the Simmance recorder through a ½ in. brass tube, and passes through two small dry governors 2½ in. diameter, connected in series. The pressure at the outlet of the second governor in the case of the instrument supplied is 11½ to 12·10ths, and is very steadily maintained within these limits. The gas rate is not quite independent of the pressure at this point; but calculation and actual trial show that, for coal gas, an increase of 0·5 p.ct. in the gas rate is produced by an increase of 6·10ths in. water gauge at this point—a change in pressure far greater than we have ever observed with these governors under their working conditions. The calorimeter will still work with an available pressure of only 5·10ths in. water gauge.

Safety Cock.—The gas next passes through the "safety cock" B, a device operated by the flowing water, and intended to cut-off the gas supply and prevent damage to the calorimeter should the water supply fail. Our experience with, and some criticism of, this device will be found in Appendix I. (1).

Connections to Meter.—Connections to the meter inlet and outlet are made by pieces of rubber tubing 5 to 6 in. long. All other connections (with one exception) are made with metallic pipes and unions. We are informed that rubber is used at this point to give the requisite freedom of movement for levelling the meter. Provided the rubber is of suitable quality, and is examined for soundness at reasonable intervals, there seems little objection to its use. A pressure-gauge inserted in one limb, and showing the pressure at the meter inlet has been found useful (C, fig. 3).

Meter.—The meter supplied is of a severely simple pattern, and passes 1·10th c.ft. per revolution; the dial being divided into 100 parts. All unions have been dispensed with, and connections to the case at the meter inlet and outlet made by soldered joints. There is a single pointer, mounted friction-tight on the meter-spindle. Where net C.V.'s are to be determined for information, if not for official purposes, a very simple counting train, even if showing up to ten revolutions only, would be a useful addition. The meter has given every satisfaction, except for a few days, when a very jerky action was traced to some of the spindle packing being drawn into the bushing. The spindle was freed and repacked. The capacity of the meter is adjusted by setting the water-line to a mark on the sight-box. According to the American Bureau of Standards, who have examined meters of this pattern, the capacity is reproducible by this method to 0·2 to 0·4 p.ct. [Technical Paper No. 36, 1914]. Since careful comparison of instruments was desired in the present investigation, all meters in use have been checked against a 1·10th c.ft. Referees' bottle, and a further check provided by running the meters in series.

No systematic errors can therefore be ascribed to differences in the relative measurement of the gas volume for the several calorimeters. The water-line is checked daily, and some adjustment found to be necessary every second or third day. There is usually a drop in the water-line equivalent to some 0·2 p.ct. in this period. Some little trouble has been encountered owing to the obscuring of the sight-glass with ferrous material derived from the meter-case. This was noticeable after one month's use of the apparatus. A small metallic reservoir is provided for supplying water to the meter.

It has been our normal practice to correct the barometric pressure for the pressure of the gas at the meter inlet.

Bye-Pass.—The gas rate is controlled by a special governor; and by means of the cock E the meter can be bye-passed without disturbing the record. Originally it was intended that this should be done, except when a check test was in progress—thereby reducing the frequency with which the meter requires to be water-lined. This is such a simple operation that there is not much point in attempting to dispense with it. Further, if the meter is bye-passed and then put in circuit for testing, the gas left in the meter may not be of the same quality as that passing at the time; and it will be necessary to wait about 15 minutes for the meter-case and governor to clear and the chart to steady again, thereby discounting the possibility of a rapid check determination at any instant. It is in practice better to close the bye-pass and leave the meter in circuit the whole time. The bye-pass

is, however, very useful, since by opening it both sides of the meter are placed under the same pressure, and water-lining can be accurately carried out without breaking any connections or interrupting the record.

Gas-Cooler.—From the meter outlet the gas passes slowly through a jacket (F) surrounding the pipe conveying the inlet water to the calorimeter. If an accurate determination of calorific value is to be made, and certain corrections are to be dispensed with, the gas and air should enter the calorimeter saturated with water vapour, and at the temperature of the inlet water. The gas as measured in the wet meter will be saturated with water vapour at the temperature of the meter, which in general will be slightly above that of the inlet water.

The gas-cooler brings down the temperature of the gas, condensing out a certain amount of water, and leaving the gas saturated with water vapour at the inlet-water temperature. If this precaution is not taken, the calorific value will be slightly too high; but as will be seen from Appendix I. (2), the error will usually be less than 0·5 B.Th.U. per c.ft., even for a difference of 5° C. or 9° Fahr. between room temperature or meter temperature and inlet-water temperature, and is consequently negligible in all cases. After leaving the gas-cooler, the gas passes through about 18 in. of metal pipe, to the inlet-valve of the "gravity governor," and it is highly probable when this point is reached the gas will have regained room temperature, but will now be in a state of only partial saturation with water vapour, holding approximately only the amount of water vapour appropriate to the lowest temperature to which the gas has been subjected. Assuming for the moment that the gravity governor passes a constant volume of gas at a given temperature and pressure, the volume registered by the meter will be this constant volume, *plus* the volume of water vapour which has been condensed out in the gas-cooler. This difference depends both upon the meter temperature and the difference between the meter temperature and inlet-water temperature, as shown in Table I. below.

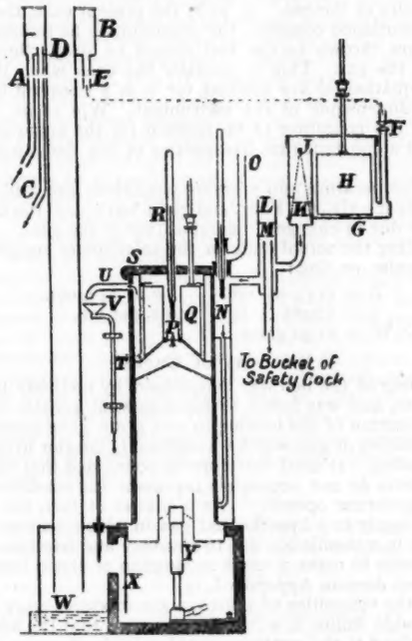


Fig. 2.—The Simmance Continuous Calorimeter.

TABLE I.—*Table Showing the Percentage Reduction in Volume Effected by Taking a Gas Saturated with Water Vapour at a Certain Temperature, Cooling to a Lower Temperature, and then Reheating as an Unsaturated Gas to its Initial Temperature.*

Temperature to which gas has been cooled.		Initial (and Final) Temperature of Gas ° Fahr.											
	°F.	84.	80.	76.	72.	68.	64.	60.	56.	52.	48.	44.	°C.
	84	—											28·9
	80	·5	—										26·7
	76	·9	·4	—									24·4
	72	1·3	·8	·4	—								22·2
	68	1·6	1·1	·7	·3	—							20·0
	64	1·9	1·4	1·0	·6	·3	—						17·8
	60	2·2	1·7	1·3	·9	·5	·2	—					15·6
	56	2·4	1·9	1·5	1·1	·8	·5	·2	—				13·4
	52	2·6	2·1	1·7	1·2	1·0	·7	·4	·2	—			11·1
	48	2·8	2·3	1·9	1·5	1·2	·8	·6	·4	·2	—		8·9
	44	3·0	2·5	2·0	1·7	1·4	1·0	·7	·5	·3	·2	—	6·7
	40	3·1	2·6	2·2	1·8	1·5	1·2	·9	·7	·5	·3	·1	4·5

The changes in volume indicated in Table I. will be without effect upon the determined calorific value of the gas when reduced to standard conditions, since they take place after the gas has been metered. With a variable difference between these temperatures, irregularities in the gas rate, and consequently in the charted calorific value, will be met with, to the extent noted in the table; the charted calorific value being too high. For a meter temperature of 60° to 68° Fahr., and for a difference of 5° C. or 9° Fahr. between meter temperature and inlet-water temperature, this error would amount to about 0·5 p.ct., or 2·5 B.Th.U., on a 500 B.Th.U. gas. The error which the gas-cooler may produce if improperly used is therefore several times greater than the error it is intended to eliminate. The alternatives would thus seem to be either dispensing with the use of the gas-cooler altogether or, if used, working with as little difference as possible between meter temperature and inlet-water temperature, and certainly not allowing this difference to exceed 2° C. if an accuracy of 1 B.Th.U. in the charted calorific value is required. It is desirable, too, for other reasons, to keep the difference between room temperature and inlet-water temperature as small as possible.

Drain Outlet Meter.—At G, a glass U-tube is provided which acts as a seal and also as a drain to the gas-cooler. Care must be taken to give the correct fall to the pipe between F and G—

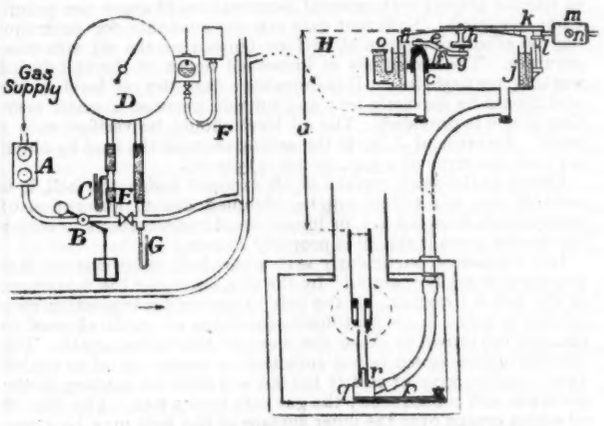


Fig. 3.—Details of the Simmance Continuous Calorimeter.

otherwise water-logging occurs there, when the condensed water accumulates. This U-tube also serves to indicate the pressure at the meter outlet.

Gravity Governor.—The gas now passes to the "gravity governor" (H), a unique device for controlling the gas rate, the regulation of which is entirely automatic. This governor, when properly adjusted, will within limits deliver such a volume of gas that, when reduced to standard conditions (60° Fahr. and 30 in. bar.), will be constant, and independent of changes in atmospheric temperature and pressure, or specific gravity of the gas being burned. In this case, the chart needs no correction for changes in temperature and pressure to reduce its readings to B.Th.U. per c.ft. at 60° Fahr. and 30 in. bar.

Before describing the mechanism in detail, the following approximate data may serve to give some idea of the magnitudes with which we are dealing, and to show that they are of a totally different order from those usually met with in calorimetric practice. The smallness of some of these quantities makes it necessary to consider several sources of error usually negligible, but in the present case of importance when compared with the other quantities involved.

The gas rate is approximately 2 c.ft. per hour.

The pressure thrown by the bell of the governor when passing coal gas of specific gravity 0·5 is equivalent to about 9·10 grms. acting at its centre.

This corresponds with a pressure of only 0·02 in. water gauge.

The foregoing quantities require to be controlled with an accuracy of 1 p.ct., if this degree of accuracy is to be obtainable on the chart; and we are thus dealing with extremely small loads and pressure changes.

Description.—Details of the governor are indicated diagrammatically in the illustration. Gas enters at *c*, the inlet passage being 7·64 in. diameter, and countersunk to form a valve-seat. The valve *d* is rigidly attached to an equal-armed lever *e*, slightly cranked, and pivoted in steel bearings at *f*. A small spherical projection at *g* receives the thrust of the valve-tappet *h*, which is provided with a plate-glass face. When in equilibrium, a difference in load of 0·05 grm. exerted at the valve-tappet will move the valve appreciably; so that as far as this point is concerned, regulation of the gas rate to within 0·2 p.ct. should be possible. Pivot friction will prevent any finer regulation than this.

Over the valve mechanism an accurately-made aluminium bell (6 in. diameter) is placed, working in an oil-seal at *j*. The bell is rigidly secured to a beam *k*, through which the valve-tappet is screwed; all joints being most carefully rendered gas-tight.

The beam itself is supported upon the points of two hardened steel screws; the one resting in a cavity in a small steel pillar and the other in a groove in the end of a similar pillar. The two together form a familiar geometrical clamp, causing the bell to oscillate in a definite direction with the minimum of frictional hindrance.

The bell is almost counterpoised by a brass cylinder *m*, about 180 grms. in weight, secured by a set-screw *n* to a plain spindle forming the right arm of the beam. A movement of this weight to the extent of 1 mm. from its correct position causes a change in the loading of the bell equivalent to 2 grms. (approximately) at its centre, or about 10 p.ct. of the "net weight" of the bell (for this term see below). Accurate adjustment by this means would seem to be a troublesome matter; but it should rarely, if ever, be necessary for the user to move the counterpoise, its original setting being a matter for the maker. Nevertheless, the tail of the spindle might be threaded, and a secondary counterpoise of (say) 12 to 20 grms. weight be mounted thereon, to provide a means of final adjustment. The specific gravity of the oil used in the oil-seal has an important influence upon the effective loading of the governor; and only that supplied by the makers should be used. It should be non-volatile; free from acid; should show no tendency to "gum" on long exposure to air; and its viscosity and surface tension should not be so great as to hinder the free movement of the bell under slight changes of load.

In Appendix I. (3) the effects of using oils of different specific gravities are discussed. It is also shown that the effects of change of specific gravity with normal temperature changes are practically negligible. Sufficient data are not available for determining the effects of change of surface tension of the oil with temperature. The variations in immersed depth of the bell during working are negligible. It is important that the oil level in the seal should be correctly set; and for this purpose a small overflow plug *o* is provided. The oil level should be verified once a week. An error of $\frac{1}{10}$ in. in the setting changes the load by about 0·4 p.ct. (an error of 1 mm. equals 0·15 p.ct.).

Owing to the small surface of oil exposed inside the bell, it is unlikely that any effects will be obtained due to absorption of constituents from the gas, or liberation of hydrocarbons to enrich the poorer gases if the oil is properly chosen.

It is necessary, particularly with a new bell, to be certain that the metal is really "wetted" by the oil; otherwise the movement of the bell is irregular. If the bell is removed for inspection, care should be taken to see that during inversion no oil is allowed to run into the crown or down the stem of the valve-tappet. The camber of the crown is not sufficient to cause the oil to run off again, and 0·1 grm. of oil left behind will alter the loading of the governor and consequently the gas rate by 0·5 p.ct. The film of oil which creeps over the inner surface of the bell may be taken as part of its permanent load. It should only occasionally be necessary to remove the bell of the governor, to see that the valve-face is clean, and that the lever is working freely on its pivots.

We have frequently removed the governor-bell during the examination of the apparatus; and check tests on the gas rate before removal of the bell and after its replacement have agreed within 0·2 p.ct. So that in this respect the governor may be regarded as perfectly reliable and reproducible as regards the relative position of its parts.

The gas leaves the governor-bell by an unrestricted ½-in. pipe, passing down to the burner-box at the base of the calorimeter. Connection to the burner is made by about 6 in. of rubber tubing. When replacement of this rubber tubing becomes necessary, smooth-bored tubing of the same length and diameter as that removed should be employed; otherwise a slight change in the gas rate may take place. [See Note, Appendix I. (4).] The gas passes through a ¼-in. tube *p*, brazed into a small cylindrical box *q*, which carries the jet *r* at the bottom of the burner.

Much trouble has been encountered owing to the very rough finish of the interior of these passages; and more regular results have been obtained after cleaning them out with a wire scratch-brush. The jet which controls the gas rate does not appear to be of a form which could be readily cleaned without damage, or alteration of its size. It is also necessary to point out the very rough finish of the orifice in the instrument under test. Irregularities of the burner due to this cause will be discussed at a later stage.

The burner is in two parts; the upper telescoping over the lower. A gauze head is fitted to the burner, above which the gas burns with a luminous flame. The telescoping of the burner allows the burning gas to be brought well up into the calorimeter, thereby reducing radiation losses from the burner, and also preventing slight reheating of the products of combustion just before they leave the calorimeter.

The flow of cold air over the burner-stem should tend to keep it cool; nevertheless conduction of heat along the burner-stem is so rapid that both the upper and lower sections become too hot to handle with comfort after the burner has been in use some little time. As the burner is surrounded by a wooden box, the loss of heat in this direction should be negligible.

Theory of the Governor.

At the outset, the case will be considered in which atmospheric temperature and pressure remain constant, and will for convenience be assumed as 60° Fahr. and 30 in. bar.—the conditions for which the governor is to be adjusted. In a first examination, the burner is not supposed to be lighted, and a number of secondary influences are not considered. These are taken into account later. The principal forces acting on the bell of the governor are: (*a*) Its weight acting downwards; (*b*) the force exerted by the counterpoise; (*c*) the flotation effect of the immersed portion of the bell, including also the surface tension of the oil; (*d*) the upward thrust of the tail-pin of the valve against the valve-tappet. These may be replaced by an equivalent force acting downwards at the centre of the bell, and which may be described as the "net weight of the bell." Such force should be constant for any given instrument, and in the present case is approximately 20 grms. There is in addition another force acting on the underside of the bell, termed by the inventor the "ascensive force."

The apparatus may be regarded as a balancing U-tube system, consisting of a right arm filled with gas, and an imaginary left arm filled with air (see illustration). Atmospheric pressure above a horizontal plane passing through the crown of the bell may be neglected as acting equally on the crown of the bell and the open end of the burner. The same is true of the gas columns below a plane through the orifice *r*. The burner-stem will be filled with gas, which may be regarded as balancing a column of equal length in the tube leading to the burner. There is then left a column of gas and a column of air of equal length, intercepted between horizontal planes through the crown of the bell and the tip of the burner; and there will be an upward thrust, or ascensive force, exerted on the under side of the bell, due to the difference in weight of these two columns.

Let W = net weight of bell in grms.
a = distance between crown of bell and tip of burner in cm.
b = area of horizontal projection of bell in sq. cm.
s = density of air in grms. c.c. (at 60° Fahr., 30 in. bar., saturated with water vapour.
g = " gas " "

The pressure thrown by the bell will therefore be

$$p_1 = \frac{W}{b} - a\,(s - g) \text{ grms. per sq.cm.} \quad . \quad . \quad . \quad . \quad (1)$$

If matters are so arranged that $\frac{W}{b} = as$,

then $p_1 = ag$ . . . . . (2)

The pressure required to discharge a gas through an orifice of fixed dimensions is proportional to the square of the gas rate and to the density of the gas. If, as in the present case, the gas rate is to be maintained constant, the condition to be fulfilled is that the pressure thrown by the bell should be proportional to the density of the gas. This is actually the case when the conditions of equation (2) are fulfilled, for a is a constant depending upon the dimensions of the instrument. $W/b = as$, therefore represents the condition to be fulfilled for the apparatus to deliver gas at a constant rate irrespective of the density of the gas supplied.

N.B.—Temperature and pressure conditions are still assumed to be constant—viz., 60° Fahr. and 30 in. bar.—and the changes in density are due to changes in composition of the gas.

Substituting the actual data for the calorimeter supplied in the above formulæ, we find:

b = 114·3 sq. cm. $\quad a$ = 81·9 cm.
$s = 1{\cdot}2265 \times 10^{-3}$ grms. per c.c.
$\therefore W$ = 11·51 grms.

Viscosity of Gases.

The loading of the bell was determined by methods to be described later, and was found to be somewhat greater than 18·5 grms. Reduction of the loading to 18·5 grms. gave governing for different qualities of gas, which was distinctly inferior to that of the original loading. It must therefore be concluded that the formulæ given above do not accurately represent the conditions under which the governor operates. As a matter of fact, the formulæ could only apply to a hypothetical gas in which no loss of pressure occurs in transmission due to viscosity and friction.

It is possible to make a rough evaluation of these losses; and this has been done in Appendix I. (5).

Though the viscosities of different gas mixtures vary between somewhat wide limits, it is found in practice that the addition of a fixed overload to the governor enables fairly close governing to be effected for most of the gas mixtures likely to be met with in practice. For the instrument examined, an increase of 12 p.ct. over the theoretical load seems to yield satisfactory results; and this brings the load up to 20·7 grms.—*i.e.*, the frictional loss is equivalent to a load of 2·2 grms., which is in good agreement with the value calculated. As indicating the difference obtainable in practice with gases which differ very little in specific gravity, but presumably more considerably in viscosity, the following figures are given:

Table II.

Gas.	Specific Gravity.	Gas Rate.	Difference.
			P.Ct.
Coal gas	0·505	100·0	..
Mixed gas containing 30 p.ct. of blue water gas . . .	0·518	99·5–99·0	0·5–1
Blue water gas	0·540	99·0–98·5	1–1·5

The tests have been repeated so often with the results always in the same direction, that the differences cannot be ascribed to accidental irregularities of the governor. Further, the variation is greater than we have obtained with gases like coal gas and Mond gas, whose densities differ so widely, and which might therefore be expected to show considerable errors if the differences were due to an imperfectly adjusted governor.

Where a works is supplying mixed gas containing different pro-

portions of blue water gas, or otherwise altering the composition of its gas, irregularities of the above kind should be borne in mind, and a close watch be kept upon the actual gas rate permitted by the governor.

Effects of Errors in Loading.

It is a matter of some importance to determine the effects of slight accidental variations in the loading of the governor, and to gain some idea of the accuracy with which the governor should be adjusted, if its automatic action is to be relied upon for gases of different densities. The following values have been calculated on the assumption that, excluding frictional losses, the load for the particular governor examined is 18·5 grms., and that for the normal gas rate the excess load to overcome frictional losses is independent of specific gravity, and equivalent to an additional load of 2·2 grms. on the bell. The correct total load is therefore 20·7 grms. The values are calculated for a reduction in load of 1 grm.; allowance being made for the small change in frictional head as the gas range changes. The differences for an increase in load of 1 grm. would be in the opposite direction, and would be substantially of the same order. The effects of smaller changes in loading can be calculated by simple proportion, with a sufficient degree of accuracy.

Table III.—*Showing the Effect upon the Rate of Gas Flow permitted by the Gravity Governor for a Reduction of 1 Grm. in the Loading of the Bell (= 5 P.Ct. of Load approximately). The Discharge with the Original Load is taken as 100·0.*

Specific gravity	0·4	0·5	0·6	0·7	0·8	0·9	1·0
Gas rate	94·0	95·1	95 8	96·4	96·1	97·1	97·4
Reduction in rate, p.ct.	6·0	4·9	4·2	3·6	3·2	2·9	2·6

It will be noted that the heavier gases are less affected by the change in loading than the lighter, and that for gases with specific gravities round about 0·5 the percentage change in the gas rate is approximately the same as the percentage change in the loading. This means that with ordinary gas mixtures the loading must be constant within 0·2 grm., if governing within 1 p.ct. is desired. The permissible variation is therefore very small, and the reason will now be apparent for discussing in an earlier part of the report the effects upon the loading of condensation of water on the bell; splashing of oil upon its surface; change in the amount of oil supported by the bell, on account of change in surface tension with temperature; shifting of the counterpoise; distortion of the bell or the bending of the screw-points upon which it is supported; and other influences which in the case of an ordinary governor would be almost negligible.

It may be that in certain cases the initial setting of the governor loading has not been exact, or perhaps there has been some subsequent displacement of parts. In this case there is a slight permanent error in the load. The normal rate will be subject to a permanent change, as distinct from an erratic change; and in the absence of definite evidence of misadjustment, the gas rate for some typical gas quality will be accepted as the normal rate for the instrument. Thus, the values of Table III. may be taken, and the rate corresponding to sp.gr. 0·5 accepted as normal. The relative deliveries with gases of other specific gravities will then be as follows:

Table IV.

Showing the effect upon the relative governing of a mis-adjustment of the gravity governor loading equal to 1 grm. or 5 p.ct. — rate with gas of sp. gr. 0·5 = 100·0.

Specific gravity	.40	·45	·50	·55	·60	·70	·80	·90	1·00
Relative gas rate	98·9	99·5	100·0	100·4	100·8	101·4	101 8	102·1	102·4
Change in rate, p.ct.	−1·2	−0 5	*Nil*	+0·4	+0·8	+1·4	+1·8	+2·1	+2·4

It will be noted that, for a range of specific gravity of 0·45 to 0·55—which will cover many commercial mixtures—the effect of a permanent 5 p.ct. error in the loading produces a variation of less than ± 0·5 p.ct. in relative gas rates, for these variations in specific gravity. In general, then, an initial adjustment of the load on the bell to an accuracy of 1 grm., or 5 p.ct., would seem to imply a uniform rate of gas supply for normal variations in specific gravity, with an accuracy within ± 0·5 p.ct.—*i.e.*, comparable with the accuracy of other parts of the apparatus. (N.B.—Temperature and pressure are still assumed to be constant.)

The general correctness of the above statements has been verified by experiment; but in determining the effects of slight changes in loading with gases of different composition and specific gravity, the results are liable to be masked by slight changes in the viscosity of the different mixtures, as already indicated.

Verification of the Loading.

The verification of the loading of the governor is an operation which the user will in general not be called upon to carry out. During the course of our investigation, however, three independent methods were developed for this purpose, and are given in Appendix I. (6), (7), and (8). The main point for our present purpose is that these determinations showed the governor to be set with such precision that no further adjustment was necessary; and any question as to irregular results being due to imperfect adjustment of the governor is thus disposed of. Incidentally, the data confirm the views so far developed as to the action of the governor. We have reason to believe that a slightly modified form of our third report has been developed independently by the makers and used by them for the initial adjustment of their gravity governors. Of the three methods the third is preferable.

Effect of Temperature and Pressure Changes on the Governor.

It has been demonstrated that the governor can be so loaded that it will deliver almost a constant volume of gas, irrespective of changes in specific gravity, when temperature and pressure are constant and the changes in specific gravity are due to changes in composition of the gas.

We now proceed to investigate the behaviour of the governor when subjected to changes in temperature and pressure, as well as changes in the specific gravity of the gas. The general scheme will be to determine, in the first place, the behaviour of the governor under ideal conditions, and with simplifying assumptions in the calculations, and subsequently to adjust the values so obtained, in order to include certain disturbing factors in the working of the governor.

The range of temperature and pressure conditions examined will be that of the "Tabular Numbers" of the Gas Referees—viz., 40° to 84° Fahr. and 28 to 31 in. bar.—as this seems to cover the greater part of the annual variation in laboratory conditions in this country. In general, of course, the working range will be much smaller than this. If temperature and pressure change so that the appropriate factor or tabular number for the reduction of the gas rate to 60° Fahr. and 30 in. bar. is n, then a volume $q \div n$ must be delivered per unit time under the prevailing conditions, to reduce to q, at 60° Fahr. and 30 in. bar.

As a first approximation, it may be assumed that the density of both the gas and air will change in proportion to n. Viscosity and frictional losses are for the time being neglected; and no complications due to a hot burner or products of combustion are taken into account. By reasoning similar to that on p. 680, the actual pressure thrown by the governor, for conditions corresponding to tabular number n, will be:

$$p_s = \frac{W}{b} - a\,(s - g)\,n \ldots\ldots\ldots (5)$$

This is to all intents and purposes the formula given by the makers in their article explaining the action of the governor.

In Appendix I. (9), the stages in the calculation are shown whereby it is possible from this formula to calculate the ratio between the volume of gas passed by the governor, and that which should be passed per hour, in order to effect exact compensation for temperature and pressure changes, under specified conditions. The results of these calculations are given in Table V., p. 682. The figures show the gas delivery for given specific gravities and tabular numbers, expressed as a percentage of the correct gas delivery in the same circumstances, assuming the above arguments to hold good.

The values inside the heavy black lines cover all those cases for which the error in governing is not greater than ± 1 p.ct., as deduced from the makers' formula.

Accurate compensation for temperature and pressure changes is clearly not possible for all specific gravities; but the area enclosed by the heavy lines in Table V. covers a range of conditions of considerable practical interest and importance in the gas industry.

The range of temperature and pressure conditions over which governing is satisfactory is greatest with gas of sp.gr. 0·5, and contracts both above and below this value. The sense, or direction, of the error, for the same tabular number, is different according as the specific gravity is greater or less than 0·5, and hence cannot be corrected by a simple adjustment of the loading of the governor. As most town's gas mixtures approach 0·5 sp.gr., the governor will in general be working under its most favourable conditions in this respect.

It is clear, however, that the instrument in its present form could not be adapted to the poorer fuel gases, such as Mond gas (sp.gr. 0·85) or producer gas, and uphold any claim to automatic compensation for temperature and pressure changes of a practically useful kind. As might be expected, governing for any quality of gas is most exact when both temperature and pressure approach the conditions under which the instrument was adjusted. In order, therefore, that positive and negative errors in governing should be evenly distributed, the governor should be set for the mean barometric height and temperature at the testing-station. In this country 62° Fahr. (indoors) and 29·5 in. barometer would seem to be good average figures, and are suggested for use in connection with method 3 for setting the governor [Appendix I. (8)]. By suitably adjusting the lever of the pen movement, the chart may be set to read the C.V. at 60° Fahr. and 30 in. bar., notwithstanding the fact that the governor may have been set for the local mean atmospheric conditions. For comparison with some later tables, the data of Table V. have been presented in an alternative form in Tables VI. A, B, and C. Here the influence of temperature and pressure changes can be distinguished; and the specific gravity range has been restricted to 0·4 to 0·6, as covering typical and limiting cases of importance in town's gas practice.

TABLE V.

RELATIVE GAS RATES (WHEN REDUCED TO 60° FAHR. AND 30 IN. BAR.) OF A CORRECTLY ADJUSTED GRAVITY GOVERNOR SUBJECTED TO TEMPERATURE AND PRESSURE CHANGES.

(PRELIMINARY TABLE FOR IDEAL GASES, BASED ON MAKERS' FORMULÆ.)

Tabular No.	Specific gravity of gas at 60° Fahr. 30 in. bar. 0·4	0·5	0·6	0·7	0·8	0·9	1·0
0·88	101·9	99·3	97·5	96·2	95·2	94·4	93 8
·90	101·7	99·5	98·0	96·9	96·0	95·4	94 9
·92	101·5	99·6	98·4	97·5	96·8	96·3	95·9
·94	101 2	99·8	98·8	98·2	97·7	97·3	96·9
·96	100·8	99·9	99·2	98·8	98·4	98 1	98·0
·98	100·5	100·0	99·6	99·3	99·2	99·1	99 0
1·00	100·0	100·0	100·0	100·0	100·0	100·0	100·0
·02	99·5	100·0	100·3	100·6	100·7	100·9	101·0
·04	98·8	99·9	100·6	101·1	101 4	101·8	102·0
·06	98 2	99·8	100·8	101 6	102·1	102·6	103·0
·08	97·5	99·6	101·2	102·2	102·9	103·5	103·9
1·10	96·7	99·5	101·3	102·6	103·6	104·4	104·9
1·12	95·9	99 3	101·5	103·2	104·3	105·3	105 8

TABLES VI.A, VI.B, VI.C. (See also figs. 3A, 3B, and 3C.)—*Showing Relative Gas Rates (when reduced to 60° Fahr. and 30 in. Bar.) Permitted by a Correctly Adjusted Gravity Governor, Working in Accordance with the Makers' Formulæ. (Alternative Statement of Data given in Table V.)*

TABLE VI.A.—*Specific Gravity = 0·40 at 60° Fahr. and 30 in. Bar.*

Temperature ° Fahr.	Barometric Height—Inches. 28	29	30	31
40	100·5	99·7	98·5	97·3
50	101·0	100·3	99·3	98·2
60	101·3	100·8	100·0	99·1
70	101·6	101·2	100·6	99·9
80	101·9	101·6	101·2	100 6

(Max. − min.) = (101·9 − 97·3) = 4·6 p.ct.

TABLE VI.B.—*Specific Gravity = 0·50 at 60° Fahr. and 30 in. Bar.*

40	100 0	100·0	99·8	99·6
50	99·9	100·0	99·9	99·8
60	99 7	100·0	100·0	100·0
70	99 5	99·8	99 9	100·0
80	99·3	99·6	99·8	100·0

(Max. − min.) = (100·0 − 99·3) = 0·7 p.ct.

TABLE VI.C.—*Specific Gravity = 0·60 at 60° Fahr. and 30 in. Bar.*

40	99·6	100·2	100·7	101·1
50	99·2	99·8	100·4	100·8
60	98·7	99·3	100·4	100·5
70	98·2	98·8	99·5	100·0
80	97·5	98·2	98·9	99·5

(Max. − min.) = (101·1 − 97·5) = 3·6 p.ct.

These tables will not be discussed in detail, because the values given for gas delivery must be subjected to some adjustment, on account of the partial validity only of certain assumptions made in deriving the formulæ used in calculating them. The general effect of these corrections is to alter somewhat the range of gas qualities and atmospheric conditions over which governing is satisfactory. The principal corrections are two in number. The first is due to the fact that, in dealing with moist gases, the density change is not in strict accordance with the assumptions made on p. 681. In extreme cases, this may give rise to errors in governing of about 1·5 p.ct. and may, according to circumstances, augment or neutralize the errors shown in Table VI. The matter is discussed in more detail, and a corrected form of Table VI. given, in Appendix I. (10).

The second correction is due to frictional losses in the gas system. It has already been shown that a small excess load must be placed on the governor to overcome friction. From the nature of the governor, this excess load is constant. The frictional loss, however (apart from differences in the viscosity of gases and changes in viscosity with temperature), will be proportional to the actual or unreduced volume of gas passing under prevailing atmospheric conditions. The difference between the actual frictional loss and that allowed for in the initial setting of the governor will appear as an extra load (it may be positive or negative), accelerating or reducing the gas rate. With very high or very low tabular numbers, this error may affect the gas rate to the extent of nearly 2 p.ct. (See Appendix I., 11.) Table VII. is a revised form of Table VI., taking account of both of the above corrections.

TABLES VII.A. VII.B, VII.C. (See figs. 5A, 5B, and 5C.)—*Showing Relative Gas Rates (reduced to 60° Fahr. and 30 in. bar.) Permitted by a Gravity Governor, Taking into Account True Density Changes in Gas with Temperature and Pressure, and Losses due to Viscosity. (Gas Rate with all Gases at 60° Fahr. and 30 in. Bar = 100·0.)*

TABLE VII.A.—*Specific Gravity = 0·40 at 60° Fahr. and 30 in. Bar.*

Temperature ° Fahr.	Barometric Height—Inches. 28	29	30	31
40	100·8	100·5	99·9	99·2
50	100·5	100·4	100·0	99·4
60	100·1	100·1	100 0	99·5
70	99·4	99·5	99·8	99 3
80	98·3	98·8	99·2	99·0

(Max. − min.) = (100·8 − 98·3) = 2·5 p.ct.

TABLE VII.B.—*Specific Gravity = 0·50 at 60° Fahr. and 30 in. Bar.*

40	100·3	100·9	101·0	101·1
50	99·7	100·2	100·5	100·7
60	98·8	99·5	100 0	100·3
70	97·8	98·5	99·2	99·6
80	96·3	97·2	98·0	98·8

(Max. − min.) = (101·1 − 96·3) = 4·8 p.ct.

TABLE VII.C.—*Specific Gravity = 0·60 at 60° Fahr. and 30 in. Bar.*

40	99·8	100·7	101·7	102·4
50	98·9	99·9	100·9	101·8
60	97·8	98·9	100·0	101·0
70	96·5	97·8	98·9	100·0
80	94·8	96·3	97·4	98·6

(Max. − min.) = (102·4 − 94·8) = 7·6 p.ct.

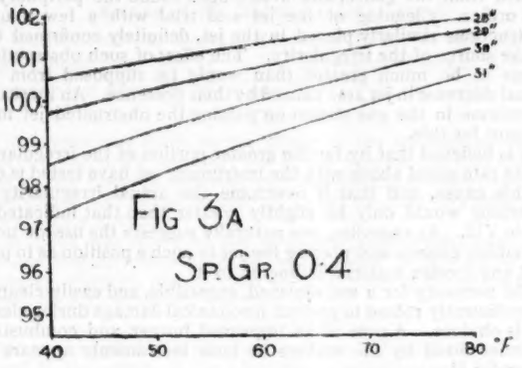
BEHAVIOUR OF GOVERNOR AS DETERMINED BY FOREGOING THEORETICAL CONSIDERATIONS.

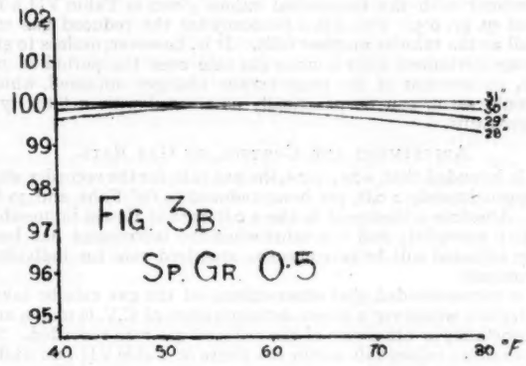
From a study of Tables VII.A, VII.B, and VII.C, or the corresponding diagrams Figs. 5A, 5B, 5C, much useful information with respect to the governor can be derived, assuming for the present that the governor responds quickly and accurately to the forces acting upon it.

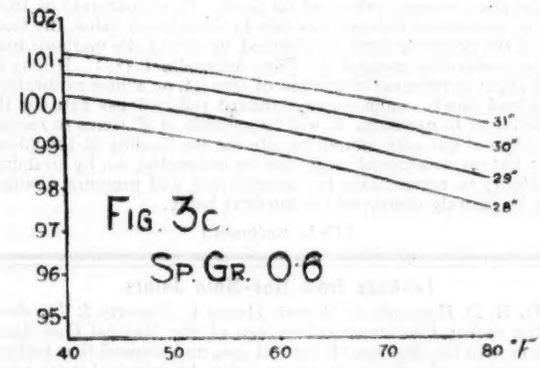
At the extreme limits of Table VII. the maximum errors for a non-compensating apparatus—*i.e.*, one delivering a constant volume of gas, irrespective of temperature and pressure changes, such as the Beasley recorder—would be + 8·5 p.ct. and − 11·9 p.ct. respectively, or ± 10·2 p.ct. about a mean value.

There is a noteworthy improvement with the Simmance governor. The maximum errors indicated in Table VII. are + 2·4 p.ct. and − 5·2 p.ct., equivalent to ± 3·8 p.ct. about a mean value; and it so happens that both these extreme values occur with a gas of sp. gr. 0·6, which is exceptional in current practice. With a gas of sp. gr. 0·5, the range is reduced to ± 2·4 p.ct., and for gas of sp. gr. 0·4, reduced to ± 1·2 p.ct. about a mean value. From this, it will be seen that the application of the various corrections has displaced the specific gravity giving the greatest range of reliable governing in Table V. from 0·5 to 0·4; and that as the specific gravity increases, the accuracy of compensation for temperature and pressure changes is reduced. While it may be advisable or necessary, in a complete investigation, to consider as wide a range of temperature, pressure, and

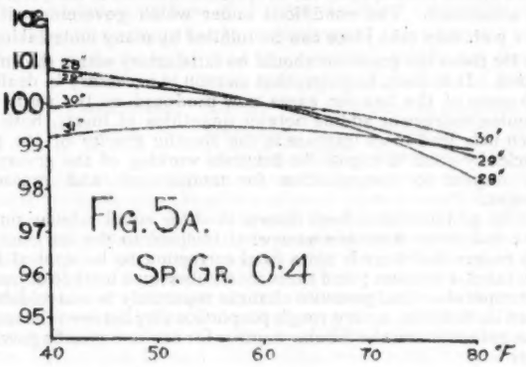
See Tables 6 A, B and C.

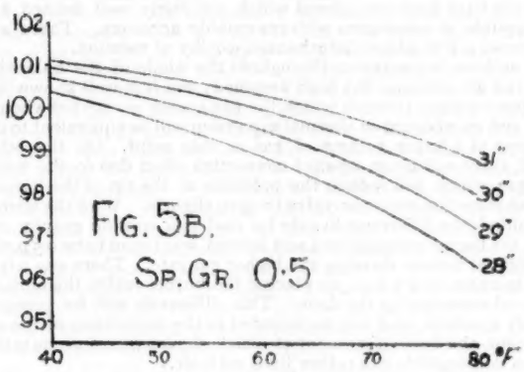


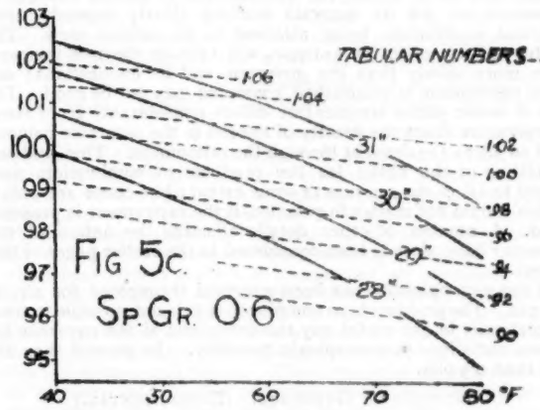




See Tables 7 A, B and C.







specific gravity conditions as is given in Table VII., the maximum errors indicated should not be wrongly interpreted and used in an unreserved condemnation of this ingenious compensating governor.

It is readily conceded that some of the limiting combinations of temperature and pressure given in the tables will only be met with on rare occasions in laboratory practice in this country. Views as to the potentialities of the governor will be very much influenced by the limits selected for normal variations in temperature, atmospheric pressure, and specific gravity for a particular undertaking.

Barometric pressure is not under control; but it is only at infrequent intervals that the barometric height falls below 28·5 in. or rises above 30·5 in. There is a distinct improvement in governing if this is taken into account; the greatest error for the same temperature range now being $\pm$ 3·3 p.ct., about a mean value in the case of gas of sp. gr. 0·6, and considerably less than this in other cases.

Similarly, it may be assumed that some attempt will be made to keep the temperature of a testing-station within reasonable limits; and variations outside 50° to 70° Fahr. should only occur occasionally, or during limited portions of the year.

Using these limits (50° to 70° Fahr.) in conjunction with a 28·5 in. to 30·5 in. barometer range, the maximum systematic variations in gas rate would appear to be:

For sp. gr. 0·4,	+ 0·5 p.ct.	to − 0·6 p.ct.	or ± 0·5 p.ct. } About a
,, ,, 0·5,	+ 0·6 ,,	to − 1·0 ,,	or ± 1·2 ,, } mean
,, ,, 0·6,	+ 1·4 ,,	to − 2·0 ,,	or ± 2·2 ,, } value.

The asymmetrical distribution of positive and negative differences given above is only apparent, and is largely due to the fact that the values were calculated for an instrument adjusted at 30 in. bar., which is considerably nearer to the normal maximum barometric pressure than to the normal minimum.

For many gas mixtures, therefore, there is a prospect of automatic governing with a considerable degree of accuracy. It is even possible that, in an artificially heated testing-station, the temperature may never fall below 60° Fahr. at any time of the year; so that the temperature range is still further reduced, and accuracy of governing consequently improved. Table VII. indicates that a certain amount of control of room temperature (say, $\pm$ 5° Fahr.) is desirable, and will materially increase the reliability of the governor. On the other hand, very elaborate thermostatic control of room temperature, within (say) $\pm$ 1° or 2° Fahr., will be difficult in execution, and is hardly justifiable; for even if successful, there is still the variation in gas rate with normal barometric changes to take into account, this being $\pm$ 0·6 p.ct. for a gas of sp. gr. 0·5, and $\pm$ 1·1 p.ct. in the case of sp. gr. 0·6, for a temperature maintained strictly at 60° or 65° Fahr.

This statement with respect to temperature control is based solely upon consideration of the governor. It may be desirable to keep the temperature within closer limits than $\pm$ 5° Fahr., having regard to the recorder as a whole, and particularly in connection with radiation gains or losses to the calorimeter itself.

It should be pointed out that the meteorological conditions giving rise to the variations we have indicated will rarely change between their outside limits in short periods of time—*e.g.*, two or three days—so that, provided adjustment of the chart is made at

reasonable intervals, the maximum uncertainty as to the chart value may in practice not be greater than one-half to two-thirds of the values shown, in so far as systematic errors of the governor are concerned. The conditions under which governing within ± 1 p.ct. may take place can be fulfilled by many undertakings; and for these the governor should be satisfactory within the limits named. It is clear, however, that caution is necessary in dealing with some of the heavier gases now produced as the result of steaming charges or adding notable quantities of inerts, both of which may lead to an increase in the specific gravity of the gas sufficiently great to impair the accurate working of the governor with respect to compensation for temperature and pressure changes.

In fig. 5C lines have been drawn to show equal tabular numbers; and these lines are somewhat inclined to the horizontal. This means that there is not a fixed correction to be applied for each tabular number; and the more cumbersome method of treating temperature and pressure changes separately is unavoidable. There is, however, a very rough proportionality between the error of the governor and the tabular number for any one specific gravity of gas.

Minor Influences Affecting the Governor.

In working out Tables VII.A, VII.B, and VII.C, those sources of error have been considered which are fairly well defined and susceptible of calculation with reasonable accuracy. There are, however, a few minor disturbances worthy of mention.

A uniform temperature throughout the whole of the balancing gas and air columns has been assumed; but it is well-known that the burner-stem through which the gas passes is very hot when in use, and on account of thermal expansion will be equivalent to the passage of a larger volume of gas at this point. On the other hand, there will be an upward convection effect due to the burning gas which will reduce the pressure at the tip of the burner, and so allow the governor-valve to open slightly. With the burner examined, the difference in rate for coal gas, specific gravity 0·5, with the burner extinguished and lighted, was found to be 0·5 p.ct.; the lighted burner showing the higher gas rate. There was a further increase of 0·5 p.ct. on placing the burner inside the burner-box and screwing-up the door. This difference will be approximately constant, and will be included in the calibration of the instrument, the final adjustment of which should therefore be made with a combustible gas rather than with air.

The instrument should not be subjected to sudden changes in temperature; for its accurate working clearly depends upon thermal equilibrium being attained in its various parts. The meter and its water, for example, will take up the new temperature more slowly than the governor and its connections; and until equilibrium is established, governing may not be good. The use of water whose temperature differs considerably from room temperature alters the density of the gas in the saturator column, and so alters the draught through the instrument. This, and any throttling of the outlet for the products of combustion, were found to affect the gas rate to some extent; but these are points which should not matter in practice, if the instrument is properly used. A number of other details affecting the action of the governor have already been considered in the earlier pages of this report.

A 100 p.ct. humidity has been assumed throughout for air, as for gas. The problem is so complex that it is not possible to treat theoretically in any useful way the deviations of the governor for known variations in atmospheric humidity. In general they are less than 0·5 p.ct.

Accuracy of Governor. (Experimental.)

It now remains to be seen how the behaviour of the governor compares in practice with that deduced from theory. Slight differences in gas rate with gases of almost identical density have been described. The excellent governing with such widely differing gases as hydrogen, coal gas, Mond gas, and air, when temperature and pressure are constant, is treated in Appendix I. (8).

The greater number of our systematic tests have been made with a mixed coal and blue water gas, of C.V. 475 to 500 gross, and a coal gas of C.V. 500 to 520 gross, with sp.gr. between 0·50 and 0·54. The minimum temperature has been 56° Fahr., and the maximum 72° Fahr. During the course of the investigation, some hundreds of determinations of the gas rate have been made; the maximum and minimum values being 2·03 and 1·70 c.ft. respectively, when reduced to 60° Fahr. and 30 in. bar., thus differing by approximately 16 p.ct.

After some weeks, it was noticeable that the irregularities took place in rather sudden steps, and that between the steps the governor was relatively consistent. Occasionally the changes took place spontaneously, but as a rule were associated with the telescoping of the burner and its replacement after examination. The erratic character of the change—sometimes a decrease and at other times an increase in the gas rate—made us hesitate to ascribe the phenomena to corrosion, in which case a continuous and more or less regular decrease in the gas rate might have been anticipated. The gauze top of the burner had suffered somewhat; and this is usually ascribed to sulphur compounds in the gas, though simple oxidation may also play its part. In the case of the burner examined, the use of gauzes of finer and coarser mesh than that supplied with the instrument, and deliberate partial obstruction of the burner-top, had relatively little effect upon the gas rate.

The burner was dismantled, and its jet found to be partially obstructed by minute particles, which had apparently been detached from the gauze, and were lodged round the periphery of the orifice. Cleaning of the jet and trial with a few minute obstructions similarly placed in the jet, definitely confirmed this as the source of the irregularity. The effect of such obstructions seems to be much greater than would be supposed from the actual decrease in jet area caused by their presence. An increased turbulence in the gas stream on passing the obstructed jet may account for this.

It is believed that by far the greater portion of the irregularity in gas rate noted above with the instrument we have tested is due to this cause, and that if overcome the actual irregularity in governing would only be slightly greater than that indicated in Table VII. As remedies, one naturally suggests the use of non-corrodible gauzes, and placing the jet in such a position as to prevent any foreign material falling on to it.

The necessity for a well-finished, accessible, and easily-cleaned jet, sufficiently robust to prevent mechanical damage during cleaning, is obvious. A note of an improved burner and combustion chamber fitted by the makers to later instruments appears in Appendix II.

Excluding the erratic changes due to jet obstructions as noted above, the behaviour of the governor has been in good general agreement with the theoretical values given in Table VII.B for gas of sp. gr. 0·5. There is a tendency for the reduced gas rate to fall as the tabular number falls. It is, however, useless to give average deviations from a mean gas rate over the period of our tests, on account of the large erratic changes obtained, which, it would seem, can be practically eliminated with a later type of apparatus.

Adjustment and Control of Gas Rate.

It is intended that, when new, the gas rate for the recorder shall be approximately 2 c.ft. per hour, reduced to 60° Fahr. and 30 in. bar. Absolute adjustment to the 2 c.ft. rate is almost impossible, nor is it essential; and the value when the instrument has been freely adjusted will be taken as the standard rate for individual instruments.

It is recommended that observations of the gas rate be taken at intervals whenever a direct determination of C.V. is made, and the constancy or otherwise of the reduced gas rate recorded. So long as these values fall within the limits of Table VII., no useful purpose will be served by attempting a readjustment of the governor. If the errors fall outside the limits of Table VII. by more than a small amount, it is advisable to clean the burner and examine the governor-valve and oil level. If adjustments of these fail to restore the reduced gas rate to its original value, the loading of the governor must be checked by one of the methods indicated, preferably method 3. [See Appendix I. (8).] It may be that slight permanent alteration of the jet, or a new calibration, may lead one to adopt a new standard reduced gas rate for the calorimeter in question. It will be possible at all times to restore the original gas rate simply by altering the loading of the governor; but on no account must this be attempted, as, by so doing, its ability to compensate for temperature and pressure changes may be entirely destroyed for the time being.

(To be continued.)

Leakage from Gas-Main Joints.

Mr. H. D. Hancock, of Messrs. Henry L. Doherty & Co., dealt at the recent Cincinnati convention of the Natural Gas Association with the leakage of natural gas, and showed that leakage from mains and services is only one of eight principal items making up the lost and unaccounted-for gas account. A systematic and carefully undertaken leakage survey is desirable, as it not only indicates the rate of leakage from each small unit of the system, but supplies exact data as to the type of main joints which are responsible for the greater portion of the loss. The experience which has been gained in the past few years in the particular systems which have undergone study in the matter of a leakage survey of the kind he described in his paper, shows that the greatest joint losses have occurred from bell-and-spigot joints in cast-iron mains. A large portion of the cast-lead joints in mains of this type were found to be leaking; the number of joint failures reaching 85 p.ct. in some systems. An analysis of the conditions which resulted in this widespread joint leakage shows that improper workmanship and material are the most important factors contributing to the joint failures, and does not indicate that this type of joint is to be generally condemned. The testing and examination of cement joints in bell-and-spigot mains revealed a still higher percentage of failures than in the case of cast-lead joints. It is a matter of record that practically every cement joint which has been tested and examined was found to be leaking. This large percentage of failures was no doubt due to various circumstances. It has been concluded, however—based upon the results of special leakage investigations in both artificial and natural gas distributing systems—that the use of cement joints in cast-iron mains was not justified by the service which has been secured. The use of bell-and-spigot pipe is often made advisable by existing conditions; and in such cases the cast-lead joint has been selected, and, when properly installed, has given highly satisfactory service. In exceptional cases only have joint failures been recorded where screw joints or the various types of rubber-packed joints were used.

NATIONAL GAS COUNCIL.

Meeting of the Central Executive Board.

A MEETING of the Central Executive Board of the National Gas Council was held at No. 30, Grosvenor Gardens, S.W., on Tuesday last week, Mr. D. MILNE WATSON in the chair.

COAL.

Reference was made to the lifting of the embargo on foreign coal for the public services; but it was pointed out that this did not go far towards relieving gas undertakings, which were still confronted with prices as high as £5 per ton, and very unsatisfactory quality at that.

Mention was made of the satisfactory results achieved by a simple and inexpensive device which could be applied to stove burners, whereby, although the calorific value of the gas might be lowered, high efficiency was secured.

ELECTRICITY.

It was reported that Counsel's opinion had been taken with regard to the action of the Electricity Commissioners recommending the supply of electricity in bulk to an urban district council by a military generating station. Counsel's written opinion had not yet been received; but considerable doubt was expressed by Counsel as to the propriety of the action of the War Department and the Electricity Commissioners in contracting to supply a public utility undertaking with electricity generated from plant erected for Government purposes out of public funds. It was stated that the Federation of British Industries were co-operating with the Council in combating the action of the Government.

Reference was made to several draft schemes with regard to electricity supplies under the Electricity (Supply) Act, 1919, affecting London and the Home Counties. These schemes propose to grant the promoters very extensive powers, including the manufacture of gas for generating purposes and the supply of surplus energy in various districts. It was agreed that the Council should watch the proceedings in the interests of the gas industry.

HOUSING SCHEMES.

A report was received from South Wales, alleging that undue preference was being given to electricity over gas in connection with two housing schemes in the area. According to the report appearing in the newspapers in South Wales, the Borough Electricity Committee stated that they were prepared to provide the necessary electric mains, and to supply electrical energy to the houses on the sites free of charge to the Housing Committee, provided such houses and the streets on the site were lighted electrically, and subject to no subsidy being paid to the Gas Company for supplying gas for cooking or other purposes to any houses and to the use of gas not being permitted for lighting purposes, and to the occupiers of the houses depositing with the electricity department such a sum as might be required by the department as payment in advance for electrical energy to be supplied. It appears from the report that clauses embodying these points are to be included in the letting agreements. The Housing Committee accepted the offer, subject to the Housing Commissioner approving the terms.

The officers of the Council were instructed to take all necessary steps for dealing with the matter.

RAILWAYS BILL.

The text of the new Railways Bill was reported upon, and the possibility of the work of the Railway Rates Advisory Committee being interfered with by the Bill. It was agreed that the Council should watch developments, and take what action they thought fit from time to time. It was reported that negotiations had been proceeding between the Federation of British Industries and the railway companies with regard to the classification of coal, coke, and patent fuel.

KEY INDUSTRIES BILL.

It was reported that, up to the present, the Council had been successful in obtaining the exclusion of gas-mantles from the scope of this Bill.

INSTITUTION OF GAS ENGINEERS.

A letter was reported from the Institution of Gas Engineers, dated May 31, regarding expenses incurred in connection with research work.

GAS REGULATION ACT.

The account from the Council's Parliamentary Agent, Messrs. Dyson, Bell, & Co., for professional services in connection with the above Act was submitted; and the Secretary was instructed to write to Messrs. Dyson, Bell, and Co., expressing the Board's appreciation of their valuable services.

SULPHATE OF AMMONIA.

The Chairman reported at length upon the present position of the market for sulphate of ammonia, and the world-wide competition which had to be met to-day. He referred to the important part which the British Sulphate of Ammonia Federation had played in stabilizing the market.

There have just been published by the Patent Office (price 2s. net) abridgements of specifications for the period 1909-15 in Class 55 (ii.) "Gas Manufacture, other than Gas Producers and Retorts."

ELECTRICITY SUPPLY MEMORANDA.

ELECTRICITY committees of various municipal undertakings are looking with anything but happy feelings at the prospects of the coming year. Many of them are reporting deficits for the past year, due largely to the price of coal and labour. But now there is the great trade depression, supplemented by the falling-off in the ability to maintain supply owing to the coal strike; and amendment from this condition will only come gradually with the return of more normal conditions in coal deliveries, and be subject to an improvement in the industrial tide. Some electricity stations secured cargoes of imported coal; and we hear that experience is as in the gas industry, that this imported coal is very variable in quality, and that the duty of boilers is not what it should be. With regard to deficits on last year's working, we see that at industrial Nottingham the shortage amounts to as much as £5050; and this is attributed mainly to the further rise in coal costs, which were 19·66 p.ct. above the price of the previous year, and 234 p.ct. above that of 1914. As to trade depression, those undertakings that were a short time ago much handicapped in the matter of making new domestic connections through the want of sufficient power and margin in their generating plant, are now utilizing the opportunity provided by slack industrial demand to peg-away at this branch of the business. Some few months ago, the Birmingham Gas Committee were doing all they could to prevail upon the City Council and the local manufacturers to provide the money for putting-in more generating plant at Nechells; but the position has materially altered. The trade depression has given them a margin of plant; and so they are connecting-up a "large number" of premises for lighting purposes. When, too, the Nechells permanent plant is in operation, a considerable number of applications for trade purposes, it is stated, can be dealt with, provided funds are available for connections. But the Committee appear to want a further £50,000 for new plant in connection with the Nechells scheme, and £15,000 for effecting changes at the Chester Street station. Whether the money will be forthcoming is not known yet; but the Committee will have to exercise care in the event of a sudden change in the industrial situation. We do not expect one; but nobody can tell what may happen in these days of quick changes, and of the composure of difficulties in the different trades. Anyway, the financial outlook for this year for those electricity undertakings that have a heavy industrial load and a relatively light domestic one is not very promising.

Deficits and Trade Depression.

The Bi-Part Tariff.

There seems to be a growing confidence in the electrical industry that the Electricity Commissioners will recommend a change in the basis of charging for electricity in the form recently discussed—that is to say, a two-part tariff, with a basis for a fixed payment as one part, and a low charge per unit consumed for the other part. A Special Committee of the Sheffield Corporation, who were appointed some time since to consider the question of the charges for electricity after passing a strange resolution which proposed to make the charges for all purposes uniform, have reported that it would appear that the ideal basis for charging for electric currrent would be a fixed price per kilo-volt ampère of maximum demand, *plus* a charge for current registered by meter, with provision for a sliding-scale covering fluctuations in the cost of coal and labour. The Committee entertain the idea—on what grounds they do not state—that a recommendation for some such "ideal basis" will be made by the Commissioners. The Committee are also persuaded that the industrial load has resulted in a substantial reduction in the price per unit, and in a very material increase in the number of units supplied per ton of coal consumed. This has been a benefit to the lighting consumers in respect of the price charged, besides which consumption in relation to light has been substantially reduced by the metallic filament lamps, and subsequently by the gas-filled lamps. The point is that the idea of the general application to electricity of a bi-partite tariff is growing.

Small Houses and the Ministry of Health.

There is rebellion in the ranks of municipal adventurers. There seem to be two policies on the move in the electrical industry as represented by authorities owning electricity supply undertakings. There are those who are convinced that the small consumer for lighting purposes only is a loss to a concern; and there is not much difficulty in showing that this is so, particularly with ruling costs, and where cables have to be laid specially for the supply of small dwellings in the occupation of the artisan class. And there are those who, with a flagrant disregard for financial issues, have made up their minds to defy any official instruction not to incur the expense for a supply of electricity for lighting when gas has to be put into dwellings under the housing schemes. These are days when the utmost economy in expenditure is called for; and the Ministry of Health refuse to sanction the unnecessary double supply. They have declined their sanction to the Stoke Newington Borough Council incurring expenditure for electrically lighting the new Lordship Grove flats. The Council have, however, resolved that, whatever decision the Ministry may have given, they will instal electricity for lighting purposes. At Liverpool, too, special

electric mains are to be laid to the several housing areas; and for this purpose the Housing Committee have decided to pay the Tramways and Electric Power and Lighting Committee the interest and sinking fund contribution on the capital expenditure. Some municipal authorities have more money than sense; or perhaps it is that sympathy for the Electricity Departments outweighs discretion.

Unremunerative Consumers.

The problem of the small and unremunerative electricity consumer is one that has not yet been solved. Such consumers detest minimum charges, which are very effective in breeding discontent. The two-part tariff has been suggested as a solution. It might result in the consumer being changed from an unproductive to a paying one; but would it make him any the more contented? "Electrical Industries" is very doubtful. Nor, in its judgment, is it by itself likely to make the consumer use more electricity. Such consumers, it remarks, have a rough notion of what they ought to pay for electric light; and any kind of arrangement which makes them pay more is certain to cause trouble. The problem is therefore still unsolved; and "Electrical Industries" can think of nothing better to improve the position of these consumers than to concentrate upon them an intensified scheme of circularization with the view to getting them to use electrical energy more for comfort and convenience. Increased costs would not conduce to "comfort or convenience." These are tenants of small houses; and yet our contemporary calls attention to electric flat-irons, kettles, hot-water jugs, hot-plates, "baby" fires, toasters, coffee-percolaters, chafing-dishes, and so on, and even to the hire purchase of such things as vacuum cleaners and washing-machines. It would be far better if this advocate would get into close contact with the conditions—financial and otherwise—existing in the majority of small houses, and he would soon find out that there is a limit in them to this secondary electrical business as there is to most other things; only in this case the limit is quickly reached.

Wiring Systems.

A good deal of consideration has recently been again given to the various systems of electric wiring—the impelling cause being economy. This is a perennial matter for discussion among electrical engineers. The subject was raised by Mr. F. T. Alldread at a meeting of the National Association of Supervising Electricians. He briefly described the various systems that are in use at the present time—calling attention to their respective advantages and disadvantages; but he did not do much, according to the reports that we have seen of the paper, in enlightening his audience as to which system meets with his personal approbation. He gave one indication, however, that he has quite an open mind as to which is the most satisfactory in all situations, other than where the wiring is likely to be subjected to mechanical damage, or where it is desired to bury it under the plaster of walls, ceilings, &c. In such cases his view is that heavy gauge screwed conduit is the most suitable. With this system there is good mechanical protection. The wire can be easily drawn out when faulty, and replaced without disturbing the decorations. It can be made practically water-tight, and gives complete protection from fire due to electrical causes, except at the fittings and switches. But there are disadvantages, as there are in every system of wiring. The wire, being encased in a conductor at earth potential, is always under electrical stress, which tends to break down the insulation, and is usually successful in doing so wherever it is at all weak, even though not low enough to be dangerous. Being water-tight, any moisture that is collected is held; and this corrodes the conduit, causing chemical action to take place in the insulation of the wire. Furthermore, where there is an excess of moisture in the air, the conduit will very quickly corrode, and thus attack the insulation. If lead-covered wire is used, electrolytic action will occur between the lead and steel—thus causing the steel to be eaten-away. This action is greatly accentuated in places where the air is charged with damp salt or acid. Of course, screwed conduit is very expensive to instal. In similar manner, Mr. Alldread dealt with the other systems, one of the most popular of which is that of wood casing and capping. For dry buildings and positions where it would not be subject to mechanical damage, this system is as good as any at present in use. But the casings must not be subjected to damp, as otherwise they become partial conductors; and the insulation of the wire will get electrically stressed, and, if weak, faults will occur. But this, Mr. Alldread submits, can be avoided by fixing the casing off the surface in damp places by means of porcelain packing pieces, and well shellacing the casing before erection. The first cost is fairly high—being the same as that of screwed conduit.

Wiring and Firing.

We cannot notice the other systems of wiring alluded to in the paper; but it is observed that, in the course of the discussion, Mr. Crowdy referred to a recent big discussion by the Wiring Rules Committee of the Institution of Electrical Engineers regarding the advisability of putting two wires in wood casing without an intervening fillet. Mr. Crowdy represented the Association upon the Committee; and he stated that he could hardly believe his own ears when the suggestion was made, and eventually agreed to, that it was safer to run two wires of opposite polarity in one groove than to run them in separate grooves. The reason put forward was that more fires had occurred through the wood fillet than from any other cause. At a subsequent discussion, however, the decision was reversed. In other discussions by the Wiring Rules Committee, he found that some consulting engineers and fire office authorities objected to running "Stannos," Henley's, or "Cab Tire" cable under floors; but he, personally does not see the difference between these systems and wood casing under floors. The objection, however, appeared to be that there was a possibility of the metal sheathing getting a kink in it, with the result that eventually there would be a blow-out in the twin cable usually employed. It is a fact that many cases have occurred of this kind with lead-covered twin cable, and fires have resulted.

Labour 60 p.ct. of the Cost.

The cost of the wiring itself is not everything. Labour is at such a price now that the system that is most economical in the labour required for its installation has much, apart from safety, in its favour. There was a reference by another speaker in the discussion to estimates in which he had been concerned for various systems of wiring workingmen's houses. A great deal has been heard of the economy of using lead-sheathed wires; but the estimates showed that the saving obtained by adopting such wire is so small in comparison with screwed conduit that it was decided to go ahead with the latter. Labour costs in installation work have gone-up out of all proportion to anything else. In 1913-14 they were about 25 p.ct. of the total cost; but now they reach 60 p.ct. Touching this point, Mr. Alldread, in his reply to the discussion, mentioned that prices he had recently got-out for wood casing and screwed conduit showed that the latter could be installed as cheaply as the former.

CONTINUOUS VERTICAL RETORTS AT HAWICK.

THE DEMPSTER-TOOGOOD SYSTEM.

Mr. H. J. Toogood's Remarks at the Waverley Association Meeting—See p. 687.

A continuous vertical retort installation, as a working whole, is, it cannot be gainsaid, a carbonizing machine; and, as such, too much importance cannot be attached to the thoroughness put into the design of its working details and component parts. On this basis is founded the "Dempster-Toogood" system; and the opinion is ventured that, whether considered from the mechanical, physical, or chemical standpoints, it will be found characterized by a particular fitness, or a fuller development, of its details. While inspecting the installation, you will see much, I trust, of interest; but this will be only "the outward and visible sign of an inward and spiritual grace." The latter feature I wish more particularly, by the aid of the diagrammatic drawings and simple working models, to make clear.

First, it is necessary to a clear understanding to note that continuous carbonization has, during the war, completely outgrown its name, inasmuch as in the "Dempster-Toogood" system—

The lower portion of the retort is wholly given over to gasification more or less complete.

The middle portion of the retort is wholly given over to high-temperature carbonization.

The upper portion is wholly given over to low-temperature distillation.

Hence one must think in terms of simultaneous gas manufacture under the three heads.

Gasification having become so important a factor, and since the process of gasification occurs only on exposed surfaces of incandescent carbon, it is necessary to high efficiency to:

(1) Increase the porosity of the charge to the maximum for the particular coal.
(2) To maintain on an even keel the descent of the charge.
(3) To spread the rising gaseous atmosphere equally over the retort area.

The models will show the method and sequence of putting these ideals into practice.

Segregation of Dusty Particles.

The coal is fed centrally to the retort, the nuts gravitate to the glass walls of the model, the dust is segregated within the mass—so much so that, in spite of there being 50 p.ct. of dust, it becomes lost to view; and the great porosity of the charge towards the corners of the retort is plainly evident. This process being continuous, the retort is maintained full of material, most lightly laid, containing the maximum porosity, offering the greatest surface areas of incandescent carbon, which areas are symmetrically disposed over the retort area; and last, but not least, the dust is away from the heated walls, ensuring the best working conditions.

Taper of the Retort Sides.

The models are exactly to scale, and illustrate the disposition of the taper, being at a maximum where the coal is expanding on first being heated, and at a minimum where the coke is shrinking.

Even Penetration of Heat.

The heating flues are symmetrically placed on each broadside of each retort, whence each and every horizontal cross-section of the charge is coked at an even rate from each side, thereby pro-

moting equality and regularity of descent, with advantage to the processes.

SUPPORTING THE WEIGHT OF THE CHARGE.

The model for weighing the charge *in situ* clearly demonstrates that 90 p.ct. of the weight of the charge is supported by thrust on the retort sides.

MAXIMUM CROSS-SECTION OF CHARGE RESTING ON THE MOVING EXTRACTORS.

Applying this ascertained knowledge, the outwardly tapering retort has been extended through the cooling chambers, so that every horizontal cross-section of the charge from the top moves ever into larger cross-sectional areas of the retort, till finally the maximum cross-section sits on the moving extractors. Thus the maximum inducement to the downward trend is established, the proclivity for the coke to bridge is overcome, and the extractors are rendered sensitive and effective throughout the length and breadth of charge. In consequence, the porosity of the expanding charge of coal is the better maintained for highest efficiencies.

COKE EXTRACTORS.

These consist chiefly of a flat tray of such size relatively to the retort that all classes of coal or coke may be contained thereon by the natural angle of repose, thereby effectively preventing the possibility of any material, even Scotch material, slipping past or over-running the tray. Consequently, when charging a retort after scurfing, no selected coke is necessary—simply charge any coke at hand.

In action, the tray slowly reciprocates about 4 inches in four minutes, the forward stroke carries coke forward from the retort, and, on the return, the coke is stationary, the tray sliding beneath; thus permitting a few pieces of coke to fall from the nose of the tray.

The model illustrates both the actions and the benefit of the twofold motion on the charge.

POWER REQUIRED.

The power required is negligibly small—1 B.H.P. The small gas-engine consumes less than 1000 c.ft. per diem.

INTIMATE STEAMING OF THE CHARGE.

Steam is introduced at 20 to 40 lbs. pressure through a ⅛-in. diameter orifice. It is obvious the hotter the steam the less the cooling effect on the incandescent carbon. Therefore the steam is superheated, and admitted above the relatively cool ironwork of the extractors, whereby the steam is not cooled.

TIGHTNESS OF RETORTS.

Steaming of continuous verticals is more or less universally employed; and as there is no scurf where steam is used over the greater area of the retort walls, it follows that the retorts must be well built, so as to remain gas-tight without the assistance of the scurf deposit.

The model illustrates the grooved-and-tongued construction, also the manner of forming the rounded corner, and brings out the unique feature of our construction—that nowhere throughout the combustion zone is there a solitary vertical joint uncovered by a stay wall. Thus is the gas-tightness so necessary to high efficiencies assured.

SAFEGUARDING REFRACTORIES.

It is possible so to dispose the ignition point or active combustion zone as to reduce the stress and strain on the most highly-heated refractories. By placing this zone between the 5 ft. and 10 ft. level from the top of the retort, the following very real advantages accrue.

The most highly heated refractories are: Subjected to the minimum weight; in position easy for resetting; relieved of extremes of temperature of the cold descending coal or rising steam; relieved of the corrosive effect of water in coal or in the steam; relieved of the wear and tear of stoker's bars; being surmounted by a W.H. regenerative flue, the descending coal is dried before reaching the highly heated refractories; and also this W.H. flue renders the bench top and ironwork relatively cool and comfortable for the men.

PRODUCER GAS.

The producer gas before entering the combustion chamber is caused, in traversing the steeply inclined flues, to precipitate most of its producer dust, with obvious advantage. The flame of combustion is vertically downwards in smooth straight flues of uniform area, whence, there being no floor or ledge to arrest dust or cause impinging, the fluxing proclivities of dust are largely overcome.

HEAT CONTROL.

There being no common regenerator, main flue, or chimney, and since each retort is an independent unit, possessing its own steam regenerator, and a S.A. regenerator for each side of each retort, it follows that: The ill-effects of atmospheric movements are largely obviated; a drop in temperature of one retort does not communicate a disturbing influence to others; each retort is controlled throughout its length by one master damper, situated at a convenient eye-level; supervision and control are considerably simplified.

In conclusion, these working models, by enabling the interior to be visualized, suggest that the retort walls of continuous vertical retorts contain a very wide domain of profitable research—probably the most fertile for immediate application.

WAVERLEY ASSOCIATION OF GAS MANAGERS.

Meeting at Hawick.

THE Annual Meeting of the Waverley Association of Gas Managers was held on Thursday, the 9th inst., at Hawick—Mr. R. PHILP of North Berwick (the President) occupying the chair.

The SECRETARY (Mr. J. D. Keillor) submitted a satisfactory statement of accounts.

The following office-bearers were elected for the year 1921-22:

President: Mr. Alex. Dow, of Galashiels.

Members of Committee: Messrs. F. Welsh, of Duns; R. S. Taylor, of Aberlady; P. Chalmers, of Kelso; J. D. Keillor, of Hawick.

THE SECRETARYSHIP.

The SECRETARY intimated his desire to resign the office of Secretary and Treasurer, owing to other claims upon his time. The members regretted Mr. Keillor's decision; and it was agreed to present him with some tangible token of their appreciation of his excellent services for the Association. After some discussion, Mr. Keillor submitted to the wishes of the members.

NEXT YEAR'S MEETING.

It was decided to hold the meeting at Galashiels.

THE PRESIDENT'S ADDRESS.

Mr. PHILP then delivered his Presidential Address, the text of which was given in the "JOURNAL" last week (p. 630).

DISCUSSION.

Mr. JOHN RICHMOND (Penicuik), in thanking the President for his address, said it gave them a few subjects for consideration and discussion. In the first place, the coal strike appeared to be everlasting, and there seemed no hope of peace up to the present time. Mr. Philp said he considered that a little more of the give-and-take policy would have avoided the strike. His own impression was that it had been too much of the give-and-take policy that had caused it; and he disagreed in this respect with Mr. Philp. In regard to carrying a huge stock of coal, this was a subject which they should consider carefully. If they collected a three months' stock based on the maximum consumption, it would be a large item and a serious thing for most companies. There was one thing which struck him as very peculiar when it came to the question of considering extensions. They looked around and said they had no ground; but they should look towards the skies, and go as high as they liked. It was not so much a matter of getting ground—it was the expense that went along with it. This was often the stumbling block. All the same, coal storage was certainly subject to a lot of drawbacks. Mr. Philp had been very fortunate in having increased his consumption during the coal strike. This was a condition which varied. No doubt in a residential district like North Berwick the consumption would be increased. He thought coke was coming into its own, and believed that the day would come when industrial users of coal would be licensed. The pushing of coal into furnaces without any respect for the waste it created, and sending half the value of the coal up the chimney should be stopped. In regard to leakage, he thought that Mr. Philp's method of main-testing created a lot of unnecessary trouble and expense. No doubt the putting of water between the bladders to make sure that there was no leakage was good; but, generally speaking, the testing of mains and meters had not received the attention it was entitled to. As to the table of purchases and sales which Mr. Philp had suggested, he could see nothing new in it; but he recommended the practice where it had not been adopted.

Mr. DAVID VASS (Perth) said that in regard to keeping coal stocks, the question to be considered was whether they had been going on the right lines hitherto, and, from the lesson of the strike, whether they could improve the situation in future. The first thing they had to consider at the time of a strike was not the manner of getting what was available in the country and thus meeting the situation. He thought it far better to have something near at hand, under the roof of his coal stores. It was important to see that the stock laid down would not deteriorate to any great extent; and every precaution should be taken to prevent it. If it was possible, it would be ideal to lay down a reserve stock fund; but he could not suggest how this was to be done. He found that stocks of coal of a soft nature laid out in the open were standing up just as well as the same class of material laid under a roof. He suggested a covering of fine coal or dross on the top of the bing for protection of the coal stored in the open; and his experience had been that the same results were obtained from such coal as that stored in the open, even after the material had been there for seven or eight years. Why should a roof be put over coal stored in the open to protect it from the weather, if a slight covering of dross had the same

effect? More than one of his neighbours had been experiencing the same benefit from the material which had been laid out in the open. He would like to hear if any other members had had this experience. Regarding the question of increasing the quantity to be stored, he thought that six weeks' maximum requirements was just a narrow enough margin. He believed that the Chairman was one of the fortunate ones in still having a fairly good stock. In his own case he had a somewhat big stock of coal at the beginning of the strike, yet had to buy in large quantities. He had obtained supplies from the Continent which had arrived on the east coast; and the material had very much the appearance of the Durham coal—about 5 to 10 p.ct. of it large, and the remainder dirt. Some of it did fairly well in the retorts; but as soon as the coke was quenched, a great quantity of it fell into small. He found in using the same coal mixed with the stocks he had in hand that the coke was better, and did not fall so much. He had also used material coming in on the west coast from America, and found it to be a fairly good coking coal, much better than the average soft coal, and sometimes nearly approaching the English coals in their coking properties. He believed one or two works had even had coal from the North of England lately, and he wished to know how they got on with working it. The coals he had bought came from America and from the Continent; and, both being of a coking nature, they were of great assistance to him in working-up his old stocks of coal. He laid down a bing of nuts two or three years ago, and in the nuts he put a mixture of a good coking nut, which gave very good results in the retorts. He advised against storing nuts alone, and recommended that a good coking quality of coal be mixed among them to ensure all-round satisfactory results.

Mr. JOHN SMITH (Stirling) suggested that three months' coal supply would, for his Company, mean a very large sum of money indeed to lay out, and if converted into £ s. d. might come to something like £10,000 to £12,000. The members and the President should turn their minds in the direction of getting more gas and more British thermal units out of the coal they had at their disposal. This would save carrying large stocks, which cost a great deal of money at the present time. They all had their coal troubles at present and the reduced qualities of gas. In his own case, he was practically sending out a straight water gas. This meant that the coal consumption had been reduced something like 50 to 60 p.ct. At present, he was sending out a gas of 380 B.Th.U. quality—carbonizing coal at a very low temperature, putting the coal into a water-gas generator with a large percentage of volatile matter, and sending it straight to the town at something like 360 to 380 B.Th.U. With a good water-gas plant or vertical retorts, they could conserve coal. Regarding the consumption of gas, the President, like himself, had felt an increase in a residential town. His consumption jumped up to a 20 p.ct. increase after asking for a reduction of 50 p.ct., which was unheeded; and then his Company were authorized to force economy on the consumers. He had cut-down the supply of gas to something like eight hours per day, and was carrying on at that. The question of leakage was one that was also receiving as much consideration as the coal supplies. It was a question gas managers had not been able to deal with for the last four years. He thought a great deal of Mr. Philp's methods of working and locating leakage. Regarding the errors in the registering of consumers' meters, those that were registering 50 p.ct. slow should be immediately take[illegible] His experience with station meters was that they showed an [illegible]ation to register slow. The President's ready reckoner and index of sales, &c., were much to be recommended for smaller works; and where the manager was practically everything in the town and had to be "hail-fellow-well-met" to everyone, he thought there was a use for a method of ready reckoning like that suggested by the President.

Mr. ALEX. DOW (Galashiels) said he had, during the past winter, experience of vertical retorts, and during the coal strike and at the present time was working a stock of coal which had been under cover for a long time, and which he had not been able to get at until now. The coal referred to had been in his works for the last three-and-a-half years, and its working brought about a small percentage of small coke. Still, he was getting better results from this coal than from coal which was stored about two months previous to the coal strike. A week ago he experimented with sawdust, and was putting this material through the vertical retort to-day. He was obtaining from a ton of sawdust something like 10,000 c.ft. He thought about five weeks' stock of coal sufficient. The President referred to the directors and members of gas committees objecting to money lying idle in coal stored in the gas-works. It was a point which would give them concern; but it was nevertheless a necessity to put down stocks of coal. Where they did object to it, let them put down some modern carbonizing plant and consume the coal in a scientific way. It was more striking than ever that gas-works would come into their own, and that this strike would not eventually be at all a bad thing for gas-works. The consumption of gas in Galashiels had increased 25 p.ct. during the strike, and, like the last speaker, he had threatened to reduce the supply of gas during the day. He had reduced the supply for two hours, and on the first day they dropped down 18 p.ct. The following day they discovered that it had gone up again; and, in his opinion, the only way of reducing the consumption was to cut off the supply altogether. He believed that coke would go up in value and be in greater demand. This was another good reason why coal should not be stored too long. The method of locating leakages was quite unique, and was a certain and sure test. He was fortunate to be in a town where the gas distribution was sectioned off by valves. It was quite a simple matter to operate a valve, and it saved the expense of breaking-up roads until it was proved there was leakage in the section. The President's practice of tabulating the average prices, &c., per ton from residuals was just the usual method; but he recommended the practice to the smaller undertakings, so that they could have before them an idea of what they were doing from month to month. He agreed with the President that there was not the interest taken in the Commercial Section there ought to be, and a little more life should be put into it. It was always interesting and beneficial to know what was going on elsewhere; and he should like to see all members of the Waverley Association send in returns regularly and fully.

Mr. JAMES BELL (Dumbarton) said the question of coal storage under all conditions was necessary; and where large stocks could not be carried, there was only one way out—that was to proceed to modern methods of carbonization. With regard to the storage of coal, his experience was much the same as Mr. Vass's. He had occasion recently to visit a neighbouring manager at his works, and he was using coal that had been lying outside for a number of years. He was struck by the appearance of it. To begin with one would have thought it was a heap of rubbish; but immediately under the surface the coal was just as bright as it was the day it was put down. This was his experience of outside storage; and he thought it needless expense to go in for large and expensive covered-in stores. With regard to leakage, during the war time his leakage might be said to have been normal; but immediately he reverted to pre-war public lighting it went up, showing that it did not matter what one rated the lamps at—there was considerably more consumed. He had rated them at 4½ c.ft., and found that on testing a few of the nipples some of them were actually passing 50 p.ct. more than the rated amount, and he was getting no better light from the lamps that were burning at the rate of 4½ c.ft. There was also the question of meter registration. During the war to some extent the meter repairs, owing to the shortage of material and labour, could not be undertaken; and this accounted for a good deal of his present leakage troubles. He had tested many meters in his day, and remembered two occasions only where the meter was registering to the advantage of the department. On the other hand, he had tested hundreds of meters and found them going anything up to 100 p.ct. slow. A very good method was to find out the age of the meters, and ferret out all that were over fifty years old and have them tested; then come down to twenty years; then, may be, ten years, and have them all tested. Where an error was found, the meter should be repaired. He started this practice in one place where he had been, and found it a great advantage, and in some cases he obtained quite a number up to 100 p.ct. slow.

Mr. J. D. KEILLOR (Hawick) said he had for seven or eight years carried a very large stock of coal, which was nearly all stored in the open. Much of it was piled-up about 30 ft. high; and he had not had any trouble with spontaneous combustion, even though it was stored outside, and no provision was made for, or preparation arranged to deal with, spontaneous combustion. He had his fears and doubts about the results likely to be obtained from this coal stored in the open so long; but, considering everything, the results were fairly satisfactory. From much of it no coke was obtained, and compared with coal stored under cover there was some little difference. He considered it necessary to carry a certain amount of stock, and believed he would continue to keep in stock at least six weeks' maximum requirements, and the whole of it under cover, if he could. They had supplied the householders and industries in the town of Hawick with many hundreds of tons; and to be able to do this and maintain a full supply of gas after a strike of eleven weeks was something he hoped the local people appreciated. There was one thing about the coal he had stored in the open, which was all drawn from the Midlothian Collieries—it was a very peculiar colour compared with the coal stored under cover. The coal was disposed of to the local factories, as a matter of fact, because it appeared to be the worst looking stuff in stock. The people of Hawick had hard things to say about the quality of it. They judged it by appearance, and said something was taken out of it before it was supplied to them. They said, "You bleach it before you send it to us." It had certainly a very bleached appearance; but the results obtained in the gas-works, while much below the average of freshly-drawn coal, had just enabled them to carry on for another week or two. So far as storage was concerned, he thought he would not do the same thing again, and would prefer to keep more under cover. Certain coals might be stored in the open without much deterioration, and the coal that lay most conveniently to a gas-works might not be among that class, and would require to be stored under cover. In the course of excavations in one of his outside stores, he had unearthed a quantity of cannel coal which had lain there for from fifteen to eighteen years—and some of it the members would be able to see in the course of their visit to the works. It was as fresh and good-looking as the day it was drawn from the pit. Speaking of his experience with Northumberland coal, he said he would not risk storing it for any length of time in the open. In his opinion, it was necessary to store English coal under cover; but he thought that certain classes of Scotch coal could be stored in the open. The fact remained that stocks would always require to be carried; and if stocks must be stored in the open, the elements would be bound to make their impression on the heap. He had English coal which had been exposed and had suffered very badly—a lump could be crushed in the hand into very small pieces. It was therefore necessary to have it protected from the elements. He had been asked by the President to prepare a brief description of the Hawick vertical retort installation for the meeting; but in the short time available it was scarcely possible to do justice to such a subject. He, therefore, did not propose to say much about the Dempster-Toogood system at Hawick—the first of its kind in Scotland—as they would all have much to see and ask while inspecting the installation. Mr. Toogood, the inventor of the system, was present, and had brought some interesting models. [The remarks of Mr. Toogood in describing the models will be found on p. 686.] Mr. Keillor explained that the Hawick vertical retort installation was first put to work early in August, 1920. The complete horizontal bench was shut-down at the same time, since when, as they had no water-gas plant, the town had been served wholly by the verticals. There had been no hitch; and after years of the trials and troubles of the horizontal retort-house, he greatly appreciated the ease and comfort of the new system of carbonization. There was no doubt about it, the Scotch coals had a great adaptability for continuous carbonization, as they passed through the retort with the greatest regularity and ease. One excellent feature of the Dempster-Toogood system was the extractor mechanism. The cooled coke was extracted with great precision by the mechanism, the easy movement of which and simplicity of adjustment should appeal to all. A very important point connected with the coke-extractors was that there was absolutely no slipping, not even when the very worst of non-coking coals or coke breeze was passing down the retorts. The tar was thin, and nothing in the nature of thick sediment had yet been seen. Bull-

ing or augering the gas off-takes was unknown; and he had not even had the experience of the charge hanging in the retort with Scotch coals. The furnaces were worked at the very low pull of 2-10ths draught, which, for Scotch coal at present available, was extremely low. He had had some unusual experience of dusty fires in these high-duty producers, which would be explained to them when viewing the installation. The heats were readily maintained at 1320° C. in the combustion chambers, at which temperature he could steadily maintain 18,000 to 20,000 c.ft. per ton of coal of 430 to 450 B.Th.U. gas, depending somewhat on the varying classes of coal. His record production was fully 23,000 c.ft. per ton of 414 B.Th.U. gas. It would interest them to know that he had for weeks supplied 380 B.Th U. gas without any complaints from power users and other consumers. The output of coal was rated on straight coal-gas production—viz., a half-million installation—2500 c.ft. per working retort; but he had no difficulty, by steaming the retorts at from 25 to 30 lbs. pressure through an ⅛-in. diameter orifice, and by conserving coal by reducing the throughput, in maintaining fully 25 p.ct. over the rating, or 3300 c.ft. per retort per hour, without increasing the normal working temperature. In conclusion, he said that, as his experience of vertical retorting grew, and particularly when it was again possible to buy fresh coals in a free market, he was sure he would have much more interesting results and figures to divulge.

The PRESIDENT thanked the various members for their remarks, and said he was surprised Mr. Richmond advocated the carrying of no stock of coal. What he expected Mr. Richmond really meant was that not more than six weeks' stock was necessary. One thing to be borne in mind in considering the question of coal storage was this. If they were going to take 50 to 70 p.ct. more gas out of the coal, the same storage would not be necessary; but he believed in having a good stock in hand. Mr. Vass spoke about storing coal outside with a covering of dross. He could not say he had had any experience of this. His experience had been rather the opposite. He had 200 tons stored outside for about two years; and the working of the coal gave results much below similar coal stored under cover which had been in stock for five years. The coal he was working on just now had been in stock for five years; and he was only sorry he had not more of it. He was fortunate, like Mr Keillor, in having a large stock when the strike began. He was not so fortunate in unearthing a stock of cannel. He appreciated Mr. Richmond's remarks about his method of locating leakage; but the number of holes was just a matter of opinion. There was no chance of a mistake with five holes; but there was a chance with three. He preferred to take no risk. Mr. Smith raised the question of the cost of maintaining a large stock of coal; and no doubt the correct way to deal with coal storage was to have the most modern plant for carbonizing installed. Unfortunately, many works had put down horizontal retorts; and with the capital account standing fairly high, it was not always possible to face the cost of more modern plant. He was interested in Mr. Dow's remarks about the sawdust. It was the first time he had heard of this material being used in vertical retorts. It was quite pleasing to hear that he obtained 10,000 c.ft. per ton and no trouble. There was no doubt that, at a pinch, it was a very good stand-by. One gentleman had informed him that he was putting out gas produced from half sawdust and half coal. In regard to valves in the distributory system, he was in the happy position of having valves all over the town, and they were used in testing the mains. The valves, however, did not always come in at the right place. In connection with leakage, he quite agreed it was necessary to test meters regularly. His experience was something similar to Mr. Bell's. It paid to watch the consumption through the various meters; and if at all suspicious they should be brought in and tested. He had been dealing more with the mains; but he would in future keep before him the possibilities of errors in the meters too.

THE ASSOCIATION'S MEDAL.

Mr. ALEX. DOW (Galashiels) presented the Association's Medal to Mr. Philp, to commemorate his year of office.

THE LUNCH.

The company were afterwards entertained to lunch by the Hawick Gas Light Company, at which the Chairman of the Company, Ex-Provost John Melrose, C.B.E., presided. After the toast of "The King," Mr. R. Philp, of North Berwick, proposed the "Hawick Gas Company," and the Chairman responded. Mr. James Henderson, of Hawick, proposed "The Waverley Association of Gas Managers," and Mr. Arch. Kellock, of Airdrie, replied. Mr. J. Richmond, of Penicuik, proposed "The Chairman," which Ex-Provost Melrose acknowledged.

VISIT TO THE GAS-WORKS.

The company inspected the gas-works in the afternoon, and much interest was exhibited in the vertical retort installation—see p. 686.

Tea was served at 5 o'clock; and this brought a most successful meeting to a close.

An Engagement.—An engagement is announced between Ashley Argenti, only son of Mrs. Ashley R. Cowan, of Wild Woods, near Enfield, and Naomi Winifred, only daughter of Maurice Graham, C.B.E., and Mrs. Graham.

Flowers Round a Gasholder.—Money spent to beautify ground round a gasholder, says the "Gas Record," must be charged up to something. What shall it be? To a gas man who knows a holder inside and out, it is a thing of beauty and interest, no matter what may be the surroundings; but to the average ordinary citizen a gasholder is not attractive. He naturally expects to see a lot of debris piled up at the base. On the other hand, if the plot of ground round a holder is made beautiful with flowers, the citizen is surprised and pleased, and unconsciously or subconsciously forms the opinion that the thing belongs to somebody, and is not merely an eyesore. If he thinks more kindly of the gas company for making the place pretty, the money spent for flowers is an investment in the "goodwill ledger." This view was taken by the Portland (Ore.) Gas and Coke Company

LOW CALORIFIC POWER GAS.

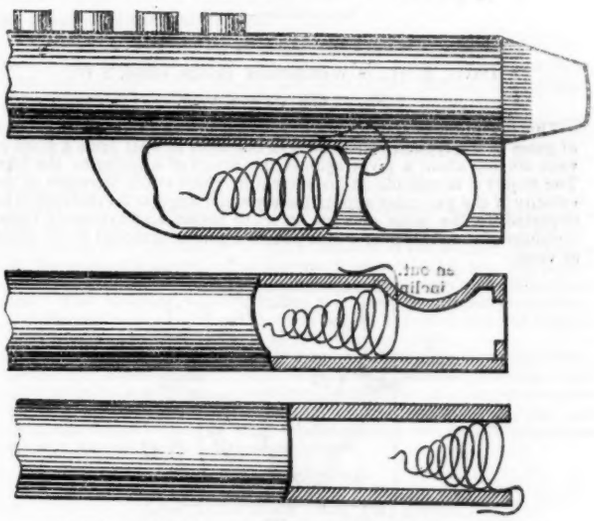
And a Simple Device for Preventing Back-Firing.

IN the minutes of the Central Executive Board of the National Gas Council, the following somewhat indefinite paragraph has appeared.

> Mention was made of the satisfactory results achieved by a simple and inexpensive device, which could be applied to stove burners, whereby, although the calorific value of the gas might be lowered, high efficiency was secured.

Inquiry of Mr. E. J. Fottrell, Manager to the Council, brought the information that more explicit particulars could be obtained of Mr. Percy S. Hoyte, the Engineer and Manager of the Plymouth and Stonehouse Gas Light and Coke Company. Extending inquiry to Mr. Hoyte, he promptly sent us samples of the little spiral device referred to, which is being attached to cooker, boiling, and fire burners, to prevent firing-back, in cases where large percentages of water gas are distributed. For the object in view the attachment is very effective.

The production and application of the device came about in this way. In the early days of the coal strike, the Plymouth Company's stock of coal was low. They had fortunately several thousands of tons of coke in the yard; and Mr. Hoyte foresaw that, were the strike prolonged, they would probably be obliged to supply 100 p.ct. of carburetted water gas. Accordingly a gas-cooker was fixed up in the laboratory, and some time was spent experimenting with various devices. Finally, Mr. Richmond, the Company's Distribution Superintendent, hit upon the one which has proved most effective. Practically every cooker in the Company's district is now equipped with the device, of which over 30,000 have been fixed. It has proved an absolute cure for all lighting-back troubles, and has the additional advantage of enabling the cooker burners to be removed for cleaning purposes without disturbing the attachment.



Methods of Attaching the Device to Different Stove Burners.

As is seen from a circular-letter Mr. Hoyte sent out regarding the device and the experiences, there is no patent in the attachment. As a matter of fact, there was no time to protect it. But the Directors of the Company and Mr. Richmond have been only too pleased to place the little device at the disposal of the industry for what it is worth. This is an extract from the circular-letter referred to:

> You may be interested to know that for the past three weeks we have shut-down our coal-gas plant entirely, and have been supplying nothing but carburetted water gas of about 435 to 440 B.Th.U. calorific value.
>
> As we anticipated, considerable trouble was experienced in the district with cooker burners firing-back; but we have entirely overcome this by means of the little attachment—devised by Mr. Richmond, our Distribution Superintendent—of which I am sending you a few samples. If you are experiencing similar trouble, you will find them very useful. We have fixed [this at the time the circular was issued] over 20,000 of them; and they have certainly saved the situation for us.
>
> There is no patent; and you can either make them yourselves, or, if you prefer, we can supply them at 35s. per 1000.
>
> To the undertakings to which samples were sent, upwards of 80,000 have been supplied; and they have been received with what can only be described as a chorus of appreciation. The result is a shoal of repeat orders.

Extensive damage attended a fire which occurred last Wednesday at the tar distillery of Messrs. Major & Co., of Hull. The flames started among the tar-stills. The city fire brigade was reinforced by the North-Eastern Railway brigade and a party of bluejackets; but water was of no avail in mastering the flames. Sand alone was effective.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

"Declared" or "Supplied" Calorific Value.

SIR,—In reference to Mr. Day's letter in the last issue of the "JOURNAL," I quite agree that it should be the duty of every engineer to supply a gas as near as possible to the declared calorific value; but it seems to me that possibly, owing to the fact that Mr. Day's Company does not come under the Gas Regulation Act, the terms of this Act, and especially those relating to the penalty clauses, may not have been fully considered by him. It will be found, on reference to these clauses, that it will be necessary for undertakings to so maintain the calorific value of the gas they supply that there is never any danger of the average for one quarter being less than the declared figure. It is obvious, therefore, that every engineer will take steps to avoid this, with the result that the gas supplied will possibly be above the declared figure.

With regard to the question as to whether any other unit than the therm should be taken for calculating working results, I am afraid I must conform to the circumstances that exist. I was in no way responsible for the therm, and, much as I shall dislike to see results worked on this small unit, I do not see very well how I can help myself. I think it would lead to confusion if I were to try and depart from the therm even to the easy extent of multiplying it by 10. The only point in my mind now is whether the expressed partiality for decimals that I am presumed to have will lead me to extend all calculations to three places of decimals instead of the customary two places.

H. E. IBBS.

Accountant's Department, The Gas Light and Coke Company, Horseferry Road, S.W. 1,
June 17, 1921.

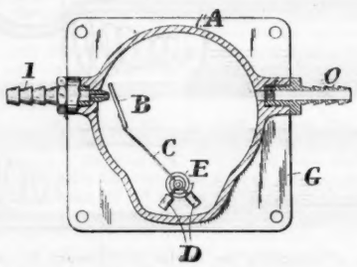
REGISTER OF PATENTS.

Flow-Meters for Gases.—No. 162,982.

DAVIS, R. H., of Westminster Bridge Road, S.W.

No. 22,689; July 3, 1920.

This invention relates to instruments for measuring the rate of flow of gases of the type in which the gas impinges as a jet upon a plate or vane moving about a pivot against the action of a spring or the like. The object is to provide an instrument in which equal increases in the velocity of the gas cause approximately equal angular movements to be imparted to the plate or vane so as to obtain approximately equal divisions of the scale over which passes a pointer attached to the plate or vane.



Davis's Flow-Meter for Gases.

The engraving illustrates in diagrammatic form a section parallel to the indicating dial of the instrument.

The outlet pipe O is provided with a disc formed with a relatively small central orifice through it, parallel to the axis of the outlet pipe; and the inlet pipe I is provided with a nozzle, the bore of which is small compared with the diameter of the pipe, as is usual in this type of instrument. The plate or vane B is connected by a light arm C to a spindle which turns about its pivot against the resistance of a hair spring E. Balance weights D are provided so that the instrument may indicate correctly in any position.

The body A of the instrument is preferably provided with a base-plate G; and a pointer attached to the plate or vane passes through a slot in a dial plate.

It will, of course, be understood that the body of the instrument is provided with a gas-tight cover holding in position a glass top through which is viewed the position of the pointer relatively to the dial.

Vertical Retort-Settings.—No. 163,150.

GLOVER, S., of St. Helens, WEST, J., of Southport, and WEST'S GAS IMPROVEMENT CO., LTD., of Manchester.

No. 5563; Feb. 24, 1920.

The object of the present invention is to provide an arrangement of steam generator with relation to a vertical retort-setting in which the hot gases ascend through to the chimney, which does not involve the employment of additional ground area and "obviates the difficulties associated with the expansion and contraction of the setting." A further object is to ensure that the waste gases reach the generator direct without the heat loss which occurs if the generator is situated at a distance from the setting. This is attained by combining with the setting superposed horizontal combustion chambers around the retorts, the waste gases from which pass upwards to a waste flue and then to the chimney on the top of the setting, and a steam generator disposed upon the top of the setting and heated by the waste gases from it—the steam generated being utilized for the "steaming" of the retorts.

Fig. 1 is a front elevation and fig. 2 a side elevation (both partly in section) of a setting containing vertical retorts having a steam generator with superheater arranged in accordance with the invention.

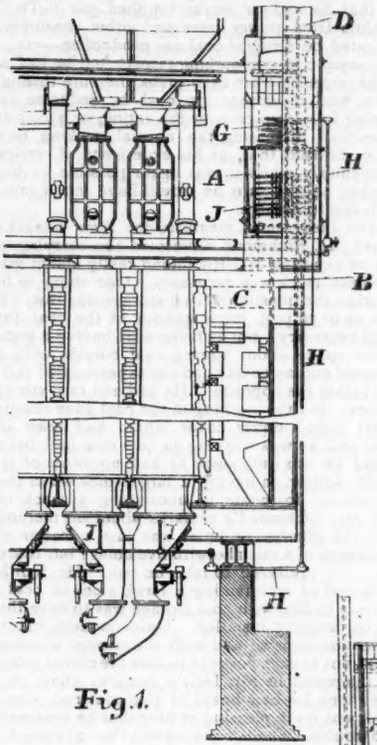


Fig. 1.

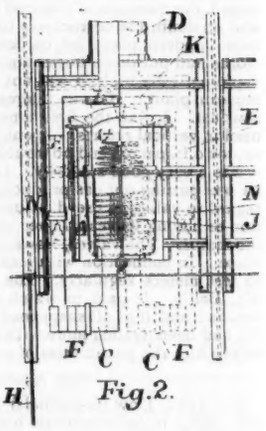


Fig. 2.

Glover and West's Arrangement for Steaming Vertical Retorts.

The steam generator A is disposed upon the top of the setting B itself and receives the waste gases which rise through the setting from the various combustion chambers around the retorts. The waste gases leave the retort by the waste-gas flue C and pass to the base of the chimney D. Thence they rise through the generator, which consists of an annular water space and cross tubes, to the chimney. There are bye-pass passages E so that, if desired, the waste gases can be passed to the chimney without going through the boiler.

In a setting comprising eight retorts, the waste gases may be delivered by two conduits C each receiving the waste gases from four retorts, to the generator, and the bye-pass conduits may be provided with control valves F for isolating one or other of the conduits or for bye-passing the whole of the waste gases so that they pass direct to the chimney instead of passing through the steam generator. Dampers N are arranged in the flues E, and dampers K at the base of the chimney above the steam generator.

If desired, there may be a steam superheater G in conjunction with the generator. Or steam as generated may be passed through conduits arranged in the walls of the combustion chambers where it will be superheated. Or the steam may pass through pipes H arranged externally to the setting.

The steam is in part utilized for "steaming" the retorts in the known manner by being injected into the coke chambers I or at any other suitable part at the base of each retort.

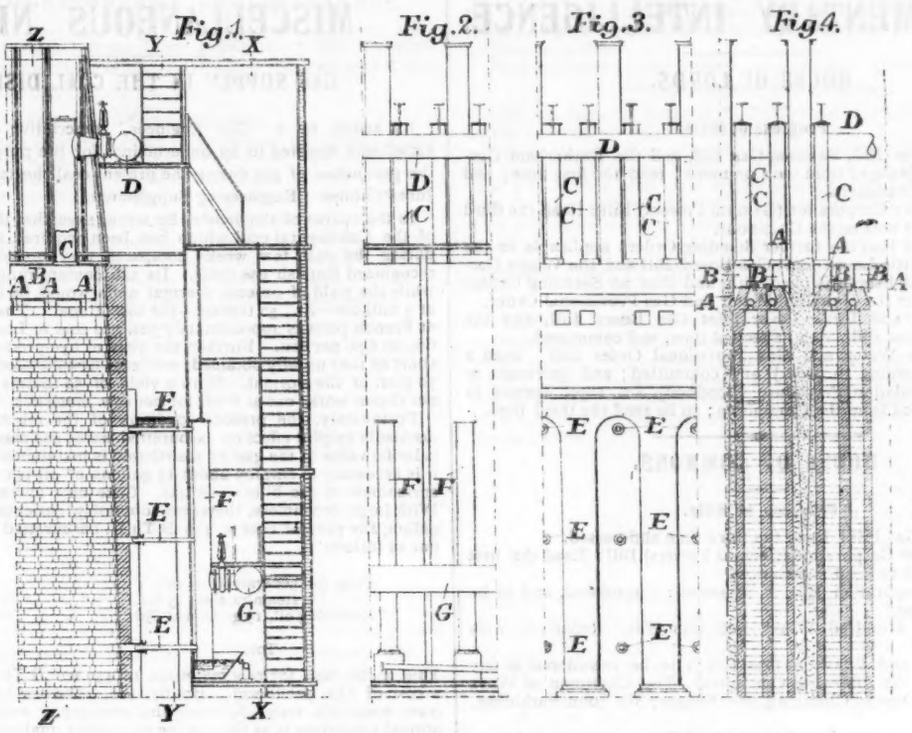
Withdrawing Gases in Vertical Retorts.

No. 163,230.

PIETERS, J., of Paris.

No. 22,352; July 27, 1920.

This arrangement provides for the complete extraction of the gas and its division into two perfectly separate portions. A first portion, com-



Pieters' Arrangement for Withdrawing Gases from Vertical Retorts.

prising all the water vapour and a low proportion of combustible gas, is evolved at a temperature lower than that of the zone of the coking action proper, in which the mass acquires a semi-liquid consistency, very impermeable to the gases, and clears a passage through the mass of coal, up to the top of the retort, where it is easily exhausted by suction. The second portion, which is formed in the lower part of the retort and comprises the great majority of the combustible gas, is practically unable to pass through the coking zone, but is exhausted at different points in the height of the retort.

When, as in the case represented, the retort is of great height, the withdrawing of gas at the top takes place through a fairly large number of openings distributed over the length of the retort and connected to a collecting main parallel to the axis of the retort but on one side of it. This collector may rest directly upon the brickwork, thus forming the upper wall of the retort. This arrangement is said to offer the advantage of facilitating the cleaning of the gas-escape openings by means of manholes formed in the top of the collecting main. The extraction of gas from the vertical part of the retort takes place in this case at the two ends which are unheated and therefore readily accessible.

Fig. 1 is a vertical section on the axis of a retort provided at its upper portion with a number of openings for the aspiration of gas, and three extraction passages on each of the unheated vertical faces. Figs. 2, 3, and 4 are transverse sections upon lines X—X, Y—Y, Z—Z of fig. 1, through a number of vertical retorts arranged to form a battery and separated merely by a heating wall or pier.

The water vapour evolved at the top of each retort, together with a part of the distillation gas, is aspirated through openings A formed at the top of the heating-piers, and passes into the collecting mains B located in pairs parallel to the retort and above same. Thence it flows into the stand-pipes C connected through a valve to the exhausting main D. A stand-pipe C is provided upon the corresponding collector B at each end of the retort, on either side of the chimney through which the material is admitted to the retort.

The greater portion of the combustible gas is withdrawn through the pipes E arranged in the two vertical unheated faces and at the lower part of the retort, above the level of the coking zone. These pipes are located in a collecting gallery and are connected to a vertical main F for each retort—leading to a common exhaust pipe G through a valve for each collecting main F.

The two exhaust pipes D and G are themselves connected to a common exhaust conduit which leads to the bye-products plant.

Purification of Ammonium Salts.—No. 163,162.

ELLIS, G. B.; a communication from the FOUNDATION OVEN CORPORATION, of New York.

No. 6206; March 1, 1920.

Ammonium sulphate is usually produced (as the patentees point out) by passing ammonia vapours through a bath of sulphuric acid: the salt crystallizing-out and being then separated from the solution by draining-off the latter, after which the salt is partially dried and further freed from acid in a centrifugal machine. There still remains a comparatively small acid content which is an impurity in the salt. Similar processes are used for producing other salts of ammonia; but in each case there remains a certain acid content as an impurity which is more or less objectionable in all these salts. This invention provides "an economical and efficient means of further purifying the salt obtained in this or any similar way."

The inventor proposes to treat the crude or impure ammonium salt with crude ammonia liquor from which the organic impurities have been first removed—this treated ammonia liquor serving to neutralize the acid content in the ammonium salt.

In plants for the manufacture of ammonium salts there is also produced an ammonia solution or crude ammonia liquor which usually contains three classes of impurities—first, solid matter, such as carbon and dirt; second, organic matters, such as tar, pyridine, phenol, cresol, acridine, &c.; third, inorganic ammonia salts, such as the carbonate, chloride, cyanate, &c. If the ammonium salt were washed with this crude ammonia liquor, the resulting salt would have a disagreeable odour or a bad colour, or both, because of the organic impurities in the ammonia liquor. The inorganic ammonia salts in the liquor would not introduce any objectionable qualities into the ammonium salt. The inventor, therefore, first removes the organic impurities, and the solids, if any, from the crude liquor, and then uses the treated liquor for neutralizing the acid in the ammonium salt.

The crude liquor is treated with a solvent for the organic impurities. Benzole or one of its homologues is suitable for this purpose, and needs only to be intimately mixed with the crude liquor in order to dissolve-out the organic impurities. The solvent is then removed, and the ammonia liquor is used to wash the ammonium salt and to neutralize all or a substantial part of the acid therein.

APPLICATIONS FOR PATENTS.

[Extracted from the "Official List" for June 15.]

Nos. 15,543 to 16,173.

BASTIAN, C. O.—"Bye-pass tap or valve for gas or liquids." No. 15,743.

BLACKSTONE, G. M.—"Means for governing and controlling air and gas mixing-valves of gas-engines." No. 15,567.

BONNARD, L. H.—"Bunsen burners." No. 15,615.

CABELL, F. H.—"Gas-main stoppers." No. 15,661.

CARTER, E. & F.—See Blackstone, G. M. No. 15,567.

DEARLE, G.—"Apparatus for extracting coke, &c." No. 16,120.

GALBRAITH, W. L.—"Gas-stoves, &c." No. 15,937.

GARDINER, H. W.—See Dearle, G. No. 16,120.

GLOVER & CO., LTD., G.—"Valve for prepayment gas-meters." No. 16,110.

HINSLEY, H.—"Gas-burners." No. 15,863.

LARKIN, F. S.—See Galbraith, W. L. No. 15,937.

MORGAN, J. S.—"Distillation of tar." No. 15,726.

NEWMAN, T. W.—"Bye-pass incandescent burners, &c." No. 15,760.

NUTTALL, T. H.—"Pump or displacer for liquids and gases." No. 15,896.

POORE, P.—"Destructive distillation of wood, woody fibres, &c." No. 16,069.

REID, D.—"Regulator for gas-burners." No. 16,138.

REYNOLDS, T.—See Dearle, G. No. 16,120.

RIDER, D.—See Morgan, J. S. No. 15,726.

SCHERHAG, A.—"Gas-operated air-heating installations." No. 16,160.

STAPLES, C. W.—See G. Glover & Co., Ltd. No. 16,110.

SUGG & CO., LTD., W.—See Galbraith, W. L. No. 15,937.

THERMAL INDUSTRIAL & CHEMICAL (T.I.C.) RESEARCH CO., LTD.—See Morgan, J. S. No. 15,726.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

Progress of Bills.

The Cardiff Gas Bill, Swansea Gas Bill, and the Rotherham Corporation Bill: Brought from the Commons; read the first time; and referred to the Examiners.

The Manchester Corporation (General Powers) Bill: Read the third time, passed, and sent to the Commons.

It was reported that the further Standing Orders applicable to the Radcliffe and Little Lever Joint Gas Board Bill and the Wigan Corporation Bill had been complied with, and that no Standing Orders were applicable to the Hamilton Water and Gas Provisional Order.

The Radcliffe and Little Lever Joint Gas Board Bill, and the Wigan Corporation Bill: Read a second time, and committed.

The Hamilton Water and Gas Provisional Order Bill: Read a second time (according to order), and committed; and (pursuant to the Private Legislation Procedure [Scotland] Act, 1899) deemed to have been reported from the Committee; to be read the third time.

HOUSE OF COMMONS.

Progress of Bills.

The Swansea Gas Bill: Read the third time and passed.

The Manchester Corporation (General Powers) Bill: Read the first time, and referred to the Examiners.

The Batley Corporation Bill, as amended: Considered, and to be read the third time.

The Tendring Hundred Water and Gas Bill: Reported, with amendments.

The Waltham and Cheshunt Gas Bill is to be considered to-day [Wednesday] by the following Committee: The Chairman of Ways and Means, the Deputy Chairman, Mr. France, Mr. John Parkinson, Sir Ernest Moon.

Gas Regulation Act, 1920.

Copies were presented of drafts of Special Orders proposed to be made by the Board of Trade under Section 10 of the Gas Regulation Act, 1920, on the application of the Harpenden District Gas Company, and the Pontypool Gas and Water Company.

Glasgow Corporation Order Confirmation Bill.

A Bill to confirm a Provisional Order under the Private Legislation Procedure (Scotland) Act, 1899, relating to the Glasgow Corporation was presented by Mr. Munro.

Gas Coke Sales Discrimination.

Mr. SITCH asked the Secretary for Mines if he was aware that a certain gas company in a Midland area had recently declined an order for coke from a local manufacturing firm whose works could only remain in operation so long as such supplies were available; that the same company was delivering quantities of coke to firms in the same district whose works had been for some time past, and were still, closed, owing to the present dispute, probably in order to accumulate stocks for use immediately the dispute was settled; whether such gas companies possessed any statutory powers enabling them to differentiate between one manufacturing firm and another; if so, by whose authority such power was exercised; and, if not, could he see his way to inquire into the specific case indicated, with a view to enabling the firm to have satisfaction of their requirements, and thus prevent any further unemployment in the area concerned.

Mr. BRIDGEMAN said he was not aware of the circumstances to which attention was called; but if Mr. Sitch would furnish the name of the gas company, the names of the manufacturing firms, and brief particulars of the transactions in coke to which he referred, he would arrange for prompt inquiries to be made.

Fraud on a Derbyshire Gas Company.

At the Chesterfield Police Court last Wednesday, Harvey Rogers, a Shirebrook tradesman, was summoned for laying a pipe which conveyed gas belonging to the Shirebrook and District Gas Company without such gas passing through the meter. An official of the Company said a collector reported that he had been to defendant's shop, and had noticed that the gas-meter was disconnected. Later witness and a constable visited the shop, and found that the pipe leading to the meter had been disconnected, and a rubber tube affixed to the end of the pipe, so that the gas did not pass through the meter for registration. Defendant, who felt his position acutely, said the light went out; and though he placed money in the meter, he could not get gas. He then put on a direct connection, not realizing that he was doing wrong. He was fined £5.

Position at Accrington.—At the Accrington Gas Board meeting on the 9th inst., the Chairman said that while actual figures could not be given, it was satisfactory to know that the Board were on the right side at the end of the last financial year. When they had their new plant installed, and when conditions became normal, they would be able to make money and reduce the price of gas. Mr. A. J. Harrison (the Manager) said, considering the two gas-works were half demolished, and bearing in mind the coal trouble, trade depression, and wage advances, the Board had been fortunate in being able to carry on without further increasing the price of gas. They had only been able to maintain gas supplies at a terrible cost. At present they were losing £1000 per week, due to decreased revenue, poor quality of coal, &c. The loss of revenue was bound to be reflected in the balance-sheet later on. However, they owed a duty to the public to maintain the gas supply.

MISCELLANEOUS NEWS.

GAS SUPPLY IN THE COAL DISPUTE.

An article by a "Gas Engineer," descriptive of the temporary expedients resorted to by undertakings for the purpose of increasing the production of gas during the present coal shortage, appears in the June "Times" Engineering Supplement.

In the course of the article the writer says that the average quality of the Continental coal which has been acquired in large quantities during the past few weeks compares very unfavourably with the recognized English gas coals. Its ash content ranges round 25 p.ct., while the yield of gaseous thermal units would be liberally estimated at 5 millions—*i.e.*, 50 therms—per ton of coal. The price of the coal at French ports is approximately 52s.; so that in London it costs from 60s. to 63s. per ton. Further, the yield of bye-products is measurably short of that usually obtained, and may be estimated on an average at 70 p.ct. of the normal. With a yield of 50 therms per ton, the cost per therm works out at 8·6d. for net raw materials.

Fortunately, the present condition of the oil market has had a decidedly helpful effect on carburetted water-gas manufacture. If the calorific value of the gas as distributed is maintained at 450 B.Th.U., it is necessary to employ about 1½ gallons of oil per 1000 c.ft. for the enrichment of the blue water gas. Coke now averages 52s. per ton. With large consumers, therefore, obtaining enriching oil at 8½d. per gallon, the present cost of 450 B.Th.U. carburetted water gas works out as follows:

	Per 1000 c.ft.
Coke for generators, 45 lbs.	12·5d.
,, steam-raising, 15 lbs.	4·2d.
Enriching oil, 1½ gallons at 8½d.	12·75d.
Total	29·45d.

This is the cost, for raw materials, of 450,000 B.Th.U., which gives a cost of 6½d. per therm. Briefly, the difference in cost per therm (raw materials only) between the emergency expedients and the normal procedure is as follows for equivalent qualities of gas:

Straight coal gas, English coal	2·25d.
,, ,, ,, Continental coal	8·60d.
Carburetted water gas.	6·50d.

The whole of the difference cannot, however, be shown in this way; for, owing to the fact that the coke yielded by Continental coals contains upwards of 30 p.ct. of ash, very considerable difficulty is experienced in maintaining the correct temperatures in the retort-benches; while water-gas manufacture with such material is an unenviable occupation. For all its drawbacks, however, French coal saved the situation at a critical period.

There is one characteristic of Continental coal which is well worthy of mention, and that is its abnormally low sulphur content. In particular, this refers to the free sulphur volatilized into the gas, as distinct from the fixed proportion remaining in the coke.

As to American coal, the author's opinion is that, though costing very much more than French coal by the time it reaches this country, it would probably be superior to the latter so far as the cost of gaseous therm production is concerned. In general, the American coals contain from 30 to 34 p.ct. of volatile matter, only 3 or 4 p.ct. of ash, and a decidedly low proportion of sulphur.

STREET LIGHTING CHARGES AT BETHNAL GREEN.

The General Purposes Committee of the Bethnal Green Borough Council report that they have given consideration to communications from the Gas Light and Coke Company, intimating an increase in the Company's charge for street lighting from April 1, at the rate of 185 p.ct. The agreement between the Council and the Gas Light and Coke Company expired on Dec. 31, 1916; but the Company have continued to light the streets at the rates payable under the agreement, despite substantially increased costs in labour and materials. The Company further state that the increased charge of 185 p.ct., based on gas at 5s. 6d. per 1000 c.ft., does not fully cover their increased charges, which are now over 200 p.ct. above pre-war costs. With a view to effecting all possible economy in street lighting, the Committee have arranged with the Company for a reduction in the consumption of gas per burner from 4 c.ft. to 3½ c.ft. per hour, effecting a saving of 2s. 8d. per burner per annum, *plus* the percentage advance of 185 p.ct.; and also for a reduction in the hours of lighting and number of lamps lit. The Committee recommend that the increased charges be paid.

The Committee further report receipt of notice from the Commercial Gas Company of increased charges for street lighting to take effect from July 1 next, varying from 164 p.ct. for one-burner lamps to 240 p.ct. for five-burner lamps. These variations in percentage increase are stated to be necessary on account of the original annual charges for three and five light lamps being too low proportionately with one-light lamps. As in the case of the Gas Light and Coke Company, the Committee have arranged for a reduction of ½ c.ft. per hour in consumption of gas, and have thereby effected a saving of from 4s. to 19s. per lamp per annum. The Committee recommend that the increased charges be agreed to.

The Secretary of the Department of Scientific and Industrial Research announces that a licence, under section 20 of the Companies (Consolidation) Act, 1908, has been issued by the Board of Trade to the British Cast-Iron Research Association, which has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The Secretary of the Association is Mr. Thomas Vickers, Central House, New Street, Birmingham.

GAS REGULATION ACT APPLICATIONS.

The following further notices have appeared in the "London Gazette" of applications by gas undertakings to the Board of Trade for Orders under the Gas Regulation Act.

Aberystwyth Gas Company.

The standard price now authorized in respect of the supply of gas by the undertakers is 4s. 3d per 1000 c.ft.; and the price which they have asked the Board of Trade to substitute for this is 1s. 8d. per therm, *plus* 3d. per therm for gas supplied through slot meters.

Banbury Gas Light and Coke Company.

The maximum price now authorized in respect of the supply of gas by the undertakers is 4s. 6d. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 6·19d. per therm.

Cambridge University and Town Gas Light Company.

The maximum prices now authorized in respect of the supply of gas by the undertakers are: (1) Within the limits of supply other than the parishes of Great Shelford, Little Shelford, Stapleford, and Fulbourn, 4s. per 1000 c.ft. (2) Within the said parishes of Great Shelford, Little Shelford, Stapleford, and Fulbourn, 6d. per 1000 c.ft. in excess of the price from time to time charged in the remainder of the limits of supply. The prices which the undertakers have asked the Board of Trade to substitute for these are: (1) Within the limits of supply other than the parishes of Great Shelford, Little Shelford, Stapleford, and Fulbourn, 1s. 3d. per therm. (2) Within the said parishes of Great Shelford, Little Shelford, Stapleford, and Fulbourn, 1 2d. per therm in excess of the price per therm from time to time charged in the remainder of the limits of supply.

Conisbrough Gas Company, Ltd.

The maximum price now authorized in respect of the supply of gas by the undertakers is 5s. per 1000 c.ft; and the price they have asked the Board of Trade to substitute for this is 2s. 2·1d. per therm.

Heathfield and Waldron Gas Light and Coke Company, Ltd.

The maximum price now authorized in respect of the supply of gas by the undertakers is 5s. 6d. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 7d. per therm.

Southbank and Normanby Gas Light and Coke Company, Ltd.

The standard price now authorized in respect of the supply of gas by the undertakers is 5s. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 9·07d. per therm.

The Company also ask for such modifications of any provisions whereby the rate of dividend payable by the undertakers is dependent upon the price of gas as may appear to the Board of Trade to be necessary.

DECLARATIONS OF CALORIFIC POWER.

Barnard Castle Gas Company.—530 B.Th.U. (June 20.)
Frome Gas Company.—450 B.Th.U. (June 20.)
Maidstone Gas Company.—490 B.Th.U. (June 15.)
Willenhall Gas Company.—540 B.Th.U. (July 1.)
Wolverhampton Gas Company.—450 B.Th.U. (June 22.)

SPECIAL ORDER.

Elland-cum-Greetland Gas Company.

The Company are making application to the Board of Trade for a Special Order under the Act to repeal provisions of the Elland Gas Act, 1901, limiting the rate of dividend and interest on preference shares or stock and mortgages; to make regulations with regard to the supply of gas, among them the supply of gas in bulk; and to make special provision with reference to the overdrawing of meters and the use of low-grade gas and high-pressure blasts, and the imposing of penalties on consumers and others in certain cases.

GAS REGULATION ACT ORDERS.

The Director of Gas Administration has forwarded copies of the following further Orders made under section 1 of the Gas Regulation Act. The parts applying specially to the Companies named, and the dates of coming into operation, are noted.

East Hull Gas Company.

As from the declared date, the maximum prices in respect of gas supplied by the undertakers shall be 16·2d. per therm and 17·4d. per therm; and these prices respectively shall be substituted for the prices of 4s. and 4s. 6d. per 1000 c.ft. mentioned in section 63 (limiting charge for supply of gas by meter) of the Sutton, Southcoates, and Drypool Gas Act, 1867.

Prepayment meter clauses are included. (June 16.)

Grantham Gas Company.

As from the declared date, the maximum price in respect of gas supplied by the undertakers shall be 20d. per therm. (June 14.)

Prescot Gas Company.

As from the declared date, the maximum price in respect of gas supplied by the undertakers shall be 17d. per therm; and this price shall be substituted for the price of 4s. per 1000 c.ft. mentioned in section 36 (maximum price of gas) of the Prescot Gas Act, 1915.

The prepayment meter clauses are included. (June 11.)

Rugby Gas Company.

After the declared date, standard prices of 16·2d. and 18·6d. per therm respectively shall be substituted for the standard prices of 3s. 8d. and 4s. 8d. per 1000 c.ft. mentioned in section 50 (dividend dependent on price charged) of the Rugby Gas Act, 1882.

For the purpose of ascertaining the authorized rate of dividend for the half year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the half year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by five.

The prepayment meter clauses are included. (June 13)

Wolverhampton Gas Company.

After the declared date, the standard prices in respect of gas supplied by the undertakers shall be 12·8d. per therm.

For the purpose of ascertaining the authorized rate of dividend for the year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by four-and-one-half. (June 10.)

LONDON COUNTY COUNCIL AND THE REGULATION ACT.

The Public Control Committee of the London County Council, reporting upon the Gas Regulation Act Orders issued by the Board of Trade to the South Suburban and the Wandsworth, Wimbledon, and Epsom Gas Companies, give the following statement showing the standard prices per therm claimed by the two Companies, the reductions suggested by the Council and the prices fixed by the Board of Trade Orders:

—	South Suburban Gas Company.	Wandsworth, Wimbledon, and Epsom Gas Company.	
		Wandsworth Limits.	Wimbledon Limits.
	d.	d	d.
Standard price per therm—			
Price claimed by the Company .	17·03	16 68	14·68
Reductions which the Council considered should be made from above figures—			
(*a*) In respect of use of figures for one year (1913-14), instead of three years (1911-12 to 1913-14)	·48	·03	·03
(*b*) In respect of use of standard calorific value as fixed by the Company's Acts, instead of "penalty" standard . . .	·09 — ·57	·71 — ·74	·56 — ·59
Company's claim, *less* proposed reductions	16·46	15 94	14·09
Standard price fixed by Board of Trade	15·00	16·60	14·60
Date of commencement of Order (1921)	April 21.	May 9.	May 9.

The South Suburban Company have declared a value of 460 B.Th.U. as from April 23, and the Wandsworth and Wimbledon Company a value of 470 B.Th.U. as from May 16. As from the first reading of meters after these dates, the Companies are required to charge for thermal units supplied at the rates set out above. The South Suburban Company have fixed the present price per therm at 14·6d. At this price, the authorized dividend would be £5 6s. 8d. p.ct. per annum, as compared with the £6 p.ct. authorized and paid in respect of the year ended June 30, 1914. The Wandsworth, Wimbledon, and Epsom Company have fixed the present price per therm at 12d. for the "Wandsworth limits," and 13·4d. per therm for the "Wimbledon limits." At these prices, the authorized dividend on the "Wandsworth A" stock would be £7 17s. 6d. p.ct. per annum, as compared with £8 7s. 6d. authorized and paid in respect of the year ended June 30, 1914, and the authorized dividend on the "Wimbledon" stock would be £5 15s. p.ct. as compared with £6 3s. 9d. p.ct. for the year ended June 30, 1914.

Buckhaven and Leven Gas Undertakings.—The Buckhaven (Fife) Town Council propose to join the Leven Town Council in applying for a Provisional Order for the amalgamation of the Buckhaven and Leven gas undertakings. Provost Smart, of Buckhaven, states that the amalgamation will give better financial results, and the working will proceed more smoothly.

Bombay Gas Company, Ltd.—At the meeting of the Company to-morrow the Directors will report that the profit for the year ended Dec. 31, as shown by the net revenue account, after allowing for interest and exchange, amounts to £22,461, making, with the £25,652 brought forward from the preceding year, £48,113 available for dividend. Deducting the interim dividend paid in November last (£11,200), there remains £36,913, out of which the Directors recommend a dividend of 4 p.ct. (less income-tax), making 8 p.ct. for the year, which will leave £25,713 to be carried forward to the current year. A strike of the Company's employees, extending over a period of eleven weeks from Oct. 1 last, has terminated satisfactorily, in that practically the whole of the employees returned to work on the Company's terms. But it necessarily involved considerable loss to the Company. The capital account is very much overdrawn. A large part of the Company's funds is employed as working capital; and owing to the strike, the collection of the revenue has been delayed. The Directors therefore deem it expedient that the payment of the final dividend shall be postponed until arrangements can be completed for the raising of additional capital. Due notice will be given when the dividend will be paid. The Directors regret to report the death, in January last, of Mr. Ernest Drew, F.C.A., who held the position of Auditor for nine years. In accordance with the Articles of Association, they have appointed Mr. Alfred Morland, F.C.A., to fill the vacancy.

LINCOLN GAS-WORKS ACCOUNTS.

The accounts of the Lincoln Corporation gas undertaking show, the City Accountant (Mr. J. H. Burgess) reports, a gross profit for the year ended March 31 of £14,226, compared with £15,491 for 1919-20; the net profit amounting to £5527, as against £7312. The expenditure increased by £23,322, owing to the high price of coal and material of all kinds, labour, rates, taxes, and heavier charges for the maintenance and repair of works, plant, and mains. Compared with the expenditure in 1913-14, there was an increase of £68,537. The income increased by £22,056, compared with the previous year, and £67,194 compared with 1913-14. In the past twelve months the receipts from residuals amounted to £42,756; the figure for the previous year having been £30,098, and for 1913-14 £17,366. The value of works, plant, and other assets, taking the works, &c., at cost, and after making substantial allowances for the depreciation of cookers and meters, is £303,985. The total liabilities amount to £112,760, of which £92,805 represents outstanding loans; and there is therefore a balance of assets of £191,224, or £98,419 more than the loan liability.

From the working results of the Manager (Mr. W. H. Mainwaring), it appears that the total quantity of gas made was 425,128,000 c.ft., as against 423 407,000 c.ft. for the year before. The make per ton of coal was 12,280 c.ft., and for 1919-20 12,003 c.ft. In his report, Mr. Mainwaring says: "During the year some of the more obvious defects in the distribution system have been made good; but there are still several districts where the service is most unsatisfactory, and it will involve very heavy expenditure to properly remedy the defects. Power has been obtained under a Temporary Increase of Charges Order to increase the price of gas above the present maximum of 4s. per 1000 c.ft. With the exception of coke, which has maintained its value, the market for residuals may be said to have practically collapsed; and the prospect for the coming year is very gloomy, especially as regards sulphate of ammonia. It is doubtful whether its manufacture will be a paying proposition, owing to keen competition with other countries, and with other sources of nitrogen, together with the high cost of labour and acid."

BOLTON CORPORATION GAS ACCOUNTS.

Reporting to the Town Council upon the results for the year ended March 31, the Bolton Gas Committee state that the quantity of gas made was 1,108,301,000 c.ft., compared with 1,069,099,000 c.ft. in the previous year; the make per ton of coal carbonized having been 14,156 c.ft., as against 14,587 c.ft. The new installation of vertical retorts at the Gas Street works should be ready by the end of September; while at Lum Street a complete gasification plant has been installed, and will be working in the course of a few weeks. The Committee say that, despite the large quantity of inferior Durham coal, amounting to over 7000 tons, which was delivered by instruction of the Coal Controller, coupled with the unsatisfactory condition of the carbonizing plant, the manufacturing results (under Mr. W. J. Smith, B.Sc., the Engineer and Manager) have been highly creditable. The number of meters fixed at March 31 was 52,221, of which 14,435 were prepayment meters. At the same date the total length of mains laid was just over 325¾ miles.

The accounts prepared by Mr. Percy Farnworth (the Borough Treasurer) show a gross profit for the past year (less payments to employees on service) of £81,155; and after deducting the various charges, there was left a sum of £33,763, as compared with £32,001 a year ago. Of this, £25,000 has been placed to depreciation and reserve fund, and £7933 has been allocated as revenue contributions to capital. The balance carried forward is £1147, as against £317 for the previous year. The capital expenditure during the year amounted to £13,368.

BAHIA BLANCA GAS COMPANY, LTD.

The Fourteenth Ordinary General Meeting of the Company was held last Thursday, at the London Offices, No. 1, East India Avenue, E.C. —the CHAIRMAN (Mr. J. M. Macmorran) presiding.

The CHAIRMAN, in moving the adoption of the report [*ante*, p. 572] and statement of accounts, said it would be seen from the revenue account that there had been a loss for the year of £6925, thereby making the total deficit to the date of the accounts £42,857. The quantity of gas sold during the year was practically the same as in the previous year. In spite of higher tariffs, there had been a heavier loss on the year, which was mainly due to the increased cost of combustibles, and also to the increased charges for labour and distribution. The debenture stockholders had waived their interest for a period of three years from Jan. 1, 1920; and for this reason debenture interest was not charged in the period under review. It might be thought that the revenue account was a doleful succession of increased costs; but these increases had been duly reported upon by the Manager, and in the opinion of the Directors were unavoidable. During 1920 the average price of all classes of combustibles was higher than ever before. Just prior to the present disastrous coal strike, prices were much reduced, and there was every prospect that the future working would be far more satisfactory. But the strike had upset their calculations again; and at the present time it was difficult to gauge its ultimate effect on international fuel markets. The reduction in prices came, of course, in 1921; and so far as 1920 was concerned, the cost of combustibles consumed per cubic metre of gas sold, after allowing for residuals produced in each case, increased by 11·8 p.ct. as compared with the previous year. Fuel oil from Plaza Huincul, to which reference was made at the last general meeting, had been received during the year; and the latest information was to the effect that the Argentine Minister of Agriculture had favourably considered the Company s application for a reduced tariff. A quarterly contract had been made at a slightly more advantageous price than that at which the Company could purchase Commodoro Rivadavia petroleum; so that, as on previous occasions, the Board had again to place on record their appreciation of the help received from the Ministry. It had been stated that the Argentine Government propose erecting tanks at Bahia Blanca for the storage of fuel oil; and if this project materialized, the Directors expected to be able to purchase supplies at more favourable rates, as it was to be presumed that the oil would be pumped straight from the tankers, and that they would save the railway freight from Buenos Aires. Indeed, if distances were anything to go by, the price should be better in Bahia Blanca than in Buenos Aires, because the former port was nearer to the source of the oil. The principle of the gas-generator to which reference had been made on previous occasions, had proved to be entirely successful; and in order to avail themselves of the idea to the fullest extent, a larger plant was being constructed. When this was in working order, it would not be necessary to put a bed of retorts into operation as now, in order to cope with the periods of heavy consumption. This would mean considerable economy in labour charges. The tariff for railway supplies was on a sliding-scale, based on fuel and labour costs. Under this arrangement, the price was increased in May, 1920. After the higher tariff was introduced, the calorific value of the gas was raised; and it was now being kept as near as possible at 3500 calories per cubic metre, which was equivalent to 393 B.Th.U. per c.ft. With regard to the prospects of Bahia Blanca, it was now thought that, so soon as cheap combustibles were available, the port would increase in prosperity, in which the Company might expect to share. He did not propose to anticipate the results for the current year. While higher tariffs might mean a reduced consumption, they hoped that the working results for the year would be more favourable. On the other hand, there would be some fairly heavy renewals of plant, which would, of course, be a revenue charge. They had in Mr. A. M. Hunter, a highly-skilled Engineer, as well as a very tactful and businesslike Manager; and it was his pleasant duty to again place on record the Board's appreciation of his efforts during the year. In common with others, they had anticipated that many of their troubles would have ended with the war. Far, however, from this being the case, they had increased, especially in the year under review; and but for the ability of the Manager, and the constant attention he gave to the business, they would have been much worse off to-day. Mr. Hunter was the last man in the world to be overcome by difficulties; and, in addition to carrying on the commercial side of the business, he was constantly undertaking experiments with the various classes of fuel available, with the object of finding a cheaper means of making gas. He was ably seconded in these efforts by his staff, who had been almost entirely trained under him. Therefore, he (the Chairman) wished to place on record their great appreciation of the work done, and difficulties surmounted, by the Manager and his staff.

Mr. P. A. COOPER seconded the motion, which was carried.

Thereafter Mr. Macmorran was re-elected a Director; and the Auditors (Messrs. Arthur Goddard and Co.) were also re-appointed.

LIGHTING OF THE NEW SOUTHWARK BRIDGE.

The new bridge opened by His Majesty the King on the 6th inst. is now in full possession of the South Metropolitan Gas Company, as far as its public lighting is concerned. This decides the fate of the bridge as to its future lighting—viz., by gas instead of by electricity. Thus again are the four Corporation bridges—the Tower, London, Southwark, and Blackfriars—gas lighted, but not with the same kind of gas lighting as in pre-war days. Much was then said and written of the high-pressure gas lighting on the City bridges; but this has given place to low-pressure gas-lamps with multiple burners and superheaters in the top of the lanterns.

Such are the new lamps on the Southwark Bridge, some ninety in all, in groups or clusters of three lanterns, surmounted on ornamental cast-iron standards rising from the parapets, and about 45 ft. apart. The lamps are not "staggered," as in ordinary road lighting, but are placed opposite one another. Each lantern is fitted with a special burner opening-out into three nozzles of the No. 2 type, with inverted mantles. By the aid of the superheater, an illumination of some 250 candles per lamp is obtained from the triple mantles. The whole is a product of the South Metropolitan Gas Company, carried out under the direction of Mr. A. Stokes, the Sales Manager, and Mr. E. M. Severn, the Company's Inspector of Public Lighting. At present, for reasons of economy, only part of the lamps are in lighting.

London Bridge has been similarly lighted by the Gas Light and Coke Company with Sugg multiple-burner superheated lamps; while on Blackfriars Bridge, the portion under the control of the Gas Light and Coke Company is fitted with "Nico" multiple-burner lamps, the South Metropolitan Company's portion being lighted by their three-burner lamps.

Girvan Gas-Works Re-started.—The Girvan Gas-Works, which have been closed for six weeks, have now been re-started. An increase in the price of gas is notified.

Dublin Gas Company's Charges.—A recently-formed Gas Consumers' Protection Committee have been very active in the Dublin area, and are inviting the support of local public bodies in a campaign to "safeguard gas consumers against excessive charges through defective meters and otherwise." At a special meeting of the Pembroke Urban Council, it was decided to give assistance to the Committee, with a view to having the consumers' grievances investigated and redressed; and a resolution was adopted calling upon the Board of Trade to refuse to accede to the Alliance and Dublin Consumers' Gas Company's application for liberty to increase the price of gas from 7s. 6d. to 8s. 4d. per 1000 c.ft. A meeting of the Blackrock Urban Council received a deputation from the Consumers' Committee, and passed a resolution welcoming the movement, and declaring that the manner in which the Gas Company discharge their duties to consumers is unsatisfactory.

GAS FOR HOUSING SCHEMES.

Lighting and Heating on the Becontree Estate.

Last November the London County Council approved the terms of a proposed arrangement with the Gas Light and Coke Company for the provision of a gas installation for the Becontree housing scheme, whereby the Company would supply gas for lighting, cooking, and heating purposes and provide certain fittings in the houses, in consideration of a capital payment by the Council of £5 a house, or £8 a house if electricity were used for the lighting. These terms did not, however, include an allowance for the laying of new mains, involving a very large expenditure which the Company were not prepared to incur. Protracted negotiations have resulted in the withdrawal of the original offer, and in the submission by the Company of proposals for the Ilford (No. 1) section of the estate, which the Housing Committee thought the Council should accept.

At last week's meeting of the Council, the Committee reported that the Company were now prepared to lay the necessary mains and services and to carry out the gas installation in 2800 houses, including the provision of a water-heater, cylinder, and hot-water piping, with a connection to the boiler behind the stove in the living-room or kitchen, upon the following terms and conditions:

The Council to pay the Company the sum of £22 a house, of which 75 p.ct. shall be paid upon the completion of the carcassing, and the balance when gas can be turned on.

The installation to be limited to houses to be provided under the assisted housing scheme in the Ilford (No. 1) section.

The Council to agree that not less than 2500 houses shall be commenced before Dec. 31, 1922.

The Council to adopt gas lighting in all "assisted scheme" houses on the Ilford (No. 1) section.

The Council to provide at their own cost a built-in gas-fire in the second bedroom of each four-roomed house in which a coal-grate has not yet been installed.

The Council to build-in a gas-fire in the second bedroom of each three-roomed house in which a coal-grate has not already been installed, provided that no excess in the cost of such installation over the cost of installing a coal-grate shall be borne by the Council.

The Council to give the Company every possible facility, during the currency of the agreement, for supplying the Council's tenants with additional gas-fires on hire.

The Council to give the Company every possible facility for laying mains and services while roads, paths, and gardens are in process of construction.

The Council to leave openings and give facilities for the running of pipes and to make good at their own expense.

The Committee went on to say that, when this question was before the Council in November, it was decided that not more than 25 p.ct. of the total number of houses to be completed within the next three years should be lighted by electricity; gas being used for cooking and heating. Owing, however, to the great cost involved in introducing both electricity and gas into the same house, they had, after consultation with the Minister of Health, reluctantly abandoned the scheme for lighting some of the working-class houses by electricity. The proposal to adopt gas lighting for all the houses to be erected on the Ilford section under the assisted housing scheme does not preclude the use of electricity in any other houses or buildings on land which may be leased by the Council. The Company's offer to provide a hot-water cylinder, and to connect it with the boiler behind the stove in the living-room or kitchen, is a substantial consideration, as it will relieve the Council of the expenditure which they would otherwise have to incur. The Minister of Health suggested that the proposed capital contribution of £22 a house should be translated into a percentage of the actual cost, and be subject, therefore, to any reduction in the price of labour or materials. The Company, however, are not prepared to accept this suggestion, but are willing to revise the rate for houses in which gas may be installed after June, 1922; and the Minister is prepared to agree to this proposal.

The Committee recommended that an agreement be entered into with the Gas Light and Coke Company; and the recommendation was agreed to by the Council.

Before this was done, however, Mr. Samuel March said he thought it was very regrettable that the Housing Committee should have capitulated to the Health Ministry and to the Gas Company in regard to the lighting and heating of houses on the Becontree Estate. The Council's resolution last November was that they should have some of these houses lighted by electricity. The Gas Company had brought all the pressure at their command to bear upon the Housing Committee, to try to make arrangements so that they might supply the heating and lighting by gas; and the Committee did not appear to be at all desirous of getting their houses up to date. Everybody who had electric light recognized that it was far superior to gas light—cleaner and healthier—and especially in those places where they had had to capitulate to the Ministry of Health with regard to the height of rooms, and so on. One would have thought the Committee would have put their backs to the wall, and been determined to have something up to date. It was an old game of the Ministry's, and had been all through—to endeavour to work in with the Gas Company. They had tried it in Poplar; but Poplar would not have it. They had an electricity undertaking, and said they would use it; and eventually the Ministry gave way to them. They would have given way to the Council in this case, if the Council had been determined; but apparently it was not to the interest of the Housing Committee to give the working classes the benefit of electric light. The truckle to gas companies was more in their interest than to see that the Municipal Authority used their electrical installation to provide lighting and heating. He was sorry the Housing Committee had decided in favour of gas; they certainly thought they were going to get something more up to date than that.

The recommendation was then agreed to.

TRADE NOTES.

[For "Journal" Advertisers.]

Simon-Carves Reinforced Concrete.

Some of the reinforced concrete structures that have been designed and erected during the past ten years by Messrs. Simon-Carves, Ltd., of No. 20, Mount Street, Manchester, are briefly described and beautifully illustrated in a booklet just prepared by them. The firm is a British one, and the staff are British; and in their business as reinforced concrete engineers, they undertake the complete job from start to finish, including the whole of the design and erection. Their work, however, is not confined to reinforced concrete. They also design and erect brick, steel, and masonry structures; and they therefore combine these materials with concrete in their design, when they are more suitable or convenient for the ultimate purpose of the structures. Messrs. Simon-Carves specialize in industrial building work; and in this connection they always aim at simplicity in design and solidity in construction. Some of the recent examples of reinforced concrete structures carried out by the firm which are illustrated in the pamphlet under notice are very extensive jobs, and for well-known collieries and coke-oven and bye-product works; and the photographs certainly show, as Messrs. Simon-Carves claim, that, with correct treatment, there is no need for industrial buildings to appear unsightly.

CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

LONDON, *June* 20.

There is very little improvement in the London tar products market. There are inquiries for pitch for export; but sellers and buyers are not yet in agreement as to price. Creosote is unchanged at from 9d. per gallon. Pure benzole and pure toluol are about 3s. net per gallon, and solvent naphtha about 2s. 9d. per gallon.

Sulphate of ammonia is unaltered.

Tar Products in the Provinces.

June 20.

The average values for gas-works products during the week were: Gas-works coal tar, 56s. to 60s. Pitch, East Coast, 72s. 6d. to 75s.; West Coast—Manchester, 67s. 6d. to 70s.; Liverpool, 67s. 6d. to 70s.; Clyde, 67s. 6d. to 70s. Benzole 90 p.ct. North, 2s. 4d. to 2s. 6d.; crude 65 p.ct. at 120° C., 1s. 11d. to 2s., naked at makers' works; 50-90 p.ct., naked, North, 2s. 3d. to 2s. 4d. Toluol, naked, North, 3s. to 3s. 1½d. nominal. Coal tar crude naphtha in bulk, North, 11d. to 11½d. Solvent naphtha, naked, North, 2s. 3d. to 2s. 4d. Heavy naphtha, North, 2s. 7d. to 2s. 9d. Creosote, in bulk, North, liquid, 9s. to 9½d.; salty, 8½d. to 8¾d. Heavy oils, in bulk, North, 10½d. to 11½d. Carbolic acid, 60 p.ct., 1s. 6d. to 1s. 9d. Naphthalene, £20 to £30; salts, £7 to £9, bags included. Anthracene, "A" quality, 10d. to 1s. per minimum 40 p.ct.; "B" quality, nominal.

[In our issue for June 9, the price of pitch (East Coast) was omitted through a clerical error. The figure should have been 70s. to 72s. 6d.]

FROM A MARKET CORRESPONDENT.

Tar Products.

There is practically nothing fresh to report in the situation. Supplies, however, are becoming scarcer, in view of the prolongation of the coal strike. Pitch remains at about 75s. per ton in London. There is a better demand for cresylic acid, and prices have advanced to 2s. 3d. per gallon for pale 97-99 p.ct. and 2s. 1d. for dark 95-97 p.ct. Solvent naphtha is dearer at 2s. 6d.—not on account of any increased demand, but on the practical exhaustion of supplies. Heavy naphtha is worth 2s. 4d. per gallon. Naphthalenes are inactive; crudes being £7 10s. nominally, and refined £18. There is no business whatever in carbolic acid, and prices are nominally 1s. 6d. per gallon for crude and 6½d. per lb. for 40 p.ct. crystals. There is scarcity in benzoles, and 90 p.ct. makes 2s. 10d. per gallon with pure at 3s. 2d. There has been rather better feeling in intermediate products on the possible settlement of the coal strike, and a few orders have been booked for delivery as early as possible after the re-opening of works. This also applies to aniline oil and salt, although quotations are practically unchanged.

Sulphate of Ammonia.

Exports during May amounted to 6109 tons, which compares with 7422 tons in April, and 18,619 tons in March. This month, however, the countries of destination show some considerable changes. For example, in March and April France was the big buyer of our sulphate of ammonia; taking over 10,000 tons in the former month and getting on for half that quantity in April. In May, however, French imports dropped to a mere 245 tons. Spain remains a fair supporter with 1943 tons; but a special place was suddenly taken by the British West India Islands. These imported in May 2259 tons, against 808 tons in April and 370 tons in March. The Dutch East Indies also advanced their figures sharply from 641 tons in April to 1410 tons in May. The only other specified buyer in May is also worth noting; Japan resuming after an interval, taking 100 tons. The home trade is very quiet; the position not being so clear as was anticipated would be the case after June 1. Trade is being effected at £18 per ton, although the Ministry of Agriculture persists in quoting £24 11s. per ton.

A surface seam of coal of much better quality than that of the "day-holes" being worked in many parts of Brighouse during the period of the fuel shortage, has been found at Lambcote Farm, where a quarrying firm are now getting the coal by the employment of 300 men. The bulk of the coal is going to the local gas-works and engineering undertakings.

No Coke-Oven Gas at Middlesbrough.

The Middlesbrough Corporation have increased the price of gas 4d. per 1000 c ft. Alderman Calvert (Chairman of the Gas Committee) stated that this advance and the previous one were due to the dislocation at the gas-works by the stoppage of coal last October, and again during the past ten weeks. The cost to the Corporation of these stoppages was something like £30,000. While generally throughout the country the rates had gone up correspondingly with those of Middlesbrough, the price of gas had not gone up in Middlesbrough in ratio to other places. There were few towns in the country of the size of Middlesbrough that had gas near the price in Middlesbrough; and with this advance of 4d., they would still be the lowest in the country. In his report to the Gas Committee, Mr. C. F. Blincoe (the Manager) stated that the continuance of the coal stoppage had accentuated the difficulty of producing gas at the coke-ovens, and had therefore reduced the quantity of gas available for town use from that source. As a result, a larger quantity of carburetted water gas was being produced by the gas-works plant. Since then, the supply of gas from the coke-ovens has stopped completely. Before the stoppage, these ovens gave 80 p.ct. of the gas consumed in Middlesbrough. The Gas Department announce that the supply of gas for cooking, heating, and lighting in the morning, at noon, and in the evening will be maintained, but that in the intervals the pressure will be so small as to be of no use.

Full Supply Maintained at Aldershot.—Remarking upon the restricted service of lighting and power that has had to be imposed in so many places consequent upon the coal strike, the "Aldershot News" says: "Residents of Aldershot must consider themselves indeed fortunate. In Guildford gas has only been available during eight hours each day; and Farnham has also been on a very limited supply. In Aldershot a full supply of gas has been maintained throughout, for which every credit is due to the foresight and aptitude of the management of the local Gas Company."

Redcar Gas-Works Purchase.—A controversy has arisen at Redcar in connection with the recent purchase of the gas-works by the Urban Council. At the time of the purchase there was sharp division of opinion among the ratepayers as to the merits of the purchase scheme. The ratepayers are not, however, involved in the present controversy—only the shareholders of the now expiring Company. By the agreement of purchase, £3000 was paid by the Council as compensation for loss of office; and this was to be distributed by the Company. It is suggested that the Directors of the Company have carried out this distribution without calling the shareholders together, and that, by a majority, half of the sum voted for compensation goes to the Gas Manager, who is retained by the Urban Council, and the other £1500 to the Directors. There is stated to be a movement among the shareholders to challenge the legality of the distribution; and solicitors have been engaged.

European Gas Company, Ltd.—The Directors announce that the profits made during the year 1920-21, which include compensation received for previous losses, have substantially reduced the adverse balance at March 31, 1920. This balance has, however, not yet been completely liquidated; and the Directors regret that they are therefore unable to recommend the payment of a dividend for the year ended March 31, 1921. The annual meeting is fixed for July 12.

A Small Loss at Hebden Bridge.—The annual report submitted last week at a meeting of the Hebden Bridge and Mytholmroyd Gas Board, showed a net loss on the past year's working of £417, compared with a net profit for the previous year of £1845. The amount of coal carbonized, it was stated, had slightly increased; but the quantity of gas manufactured was smaller, owing to the poor coal. Wages had increased materially.

Bradford and Summer Public Lighting.—The Bradford Corporation Finance Committee have set up a Special Joint Sub-Committee, comprising three members of the Finance, Gas, and Electricity Committees, to inquire into, and report to the Corporation upon, the practicability of the suspension of street lighting for the three summer months of June, July, and August, year by year, as a measure of public economy—quite apart from the present question of coal shortage. One of the problems is as to the position of the gas-lamp lighters whose services will be suspended.

London Fair and Market.—Mantles will be exhibited by Messrs. Curtis's and Harvey, Ltd., at the London Fair and Market to be held at the Royal Agricultural Hall from July 4 to 15 inclusive, on the stand (No. 16/32 in the Main Building) of Nobel Industries, Ltd., with whom the firm are associated. On the stand will be shown working exhibits of the manufacture of "Ironclad" gas-mantles, together with raw materials in various stages of manufacture, and samples of soft and collodionized ramie silk and cotton mantles, both upright and inverted, for high and low pressure gas-burners, spirit, oil, and acetylene lamps and lanterns. The mantles will bear the familiar "Ironclad" trade mark, and are manufactured at the Earlsfield and Dartford factories of Messrs. Curtis's and Harvey, Ltd.

Temporary Cessation of Supply at Keighley.—Mr. W. H. Murgatroyd (the Chairman of the Gas Committee), reporting to the Keighley Town Council last week that what gas was being made was drawn off as fast as it was produced, said the situation was due to poor coal. Though the department were nearly on their "beam ends" three weeks previously, they had managed to carry-on until a couple of days ago. They had plenty of coke at the beginning of the strike, and had no reason to contemplate shortage; but the inferior coal since obtained made such poor coke that the proper heat could not be maintained in the retorts. The gas supply would be cut off for the next few days, so as to give a decent week-end supply; but it was hoped that a new quality of coal bought would be found, on delivery, to produce better coke. On behalf of the Council, the Mayor complimented the Gas Department on the way they had pulled through.

ECONOMY OF COAL

This Testimonial

FROM A GAS ENGINEER

Should Convince You

DEAR SIRS, 1st *April*, 1921.

It may interest you to know the result of your suggestion that we should coat the front of our retort benches with "Everok" for the preservation of the brickwork and at the same time the conservation of heat.

I might first mention that we were unable to carry out your suggestion to apply the "Everok" by means of a spraying machine as such was not available and consequently had no alternative but to apply the "Everok" with an ordinary hand brush.

Even with this superficial application I am pleased to inform you that the brickwork shows absolutely no deterioration whatever after nine months' continuous use, although in the ordinary course of events (due to our unfortunate method of working) we should have anticipated signs of deterioration within two months. The preservation of the brickwork is so remarkable that I estimate we have already saved the cost of material and labour many times over apart from the question of economy in fuel. Even the workmen remark how nice and cool it is in front of the bench treated with "Everok."

Whilst I shall be delighted to allow any Engineer to inspect the Retort Bench in question and obtain any information he may require, I think the cost of labour and materials necessary to coat an ordinary retort bench so small compared with the remarkable results obtained that I have no hesitation in recommending every Gas Engineer to make the experiment for himself.

Yours faithfully,
Name on application.

Is a colourless solution on the "NO-VOID" principle for rendering the surface of EXISTING CEMENT, CONCRETE, STUCCO, BRICK, STONE, &c., impervious to water or the destructive action of nature.

Manufactured by

THE TORBAY & DART PAINT CO., Ltd., 26, 27 & 28, Billiter St., LONDON, E.C.

Bingley Gas Supply Gives Out.—Owing to the exhaustion of coal supplies and the poor coke for retort heating at the Bingley (Yorks.) Gas-Works, the supply of gas came to an end during last week, though hopes were entertained of getting some fuel within a few days.

Effect of the Strike at Haworth.—It was reported to the Haworth District Council that the effects of the coal strike have wiped-out the balance in hand on the gas-works, causing a loss of over £1000 since the advent of the strike; and the loss will be greater because of the high price of what coal can be obtained. The Haworth Gas-Works have normally been very successful. The Council have given the Committee power to raise the price as may be necessary.

Coventry Gas Accounts.—The accounts of the Coventry Corporation gas undertaking for the year ended March 31 last show that the profit on the working was £31,516. Capital expenditure to the amount of £30,522 was, however, defrayed out of revenue, so that the balance was reduced to £994. Adding the sum of £35,173 brought forward from last year, there is a disposable balance of £36,167; and the Gas Committee are recommending that the whole of this be carried forward to the next account.

James Keith and Blackman Company.—After providing for debenture interest, excess profits duty, corporation tax, and making allowance for depreciation, &c., the net profit of the Company for the year ended March 31 last amounts to £49,670, against £53,659 for the previous year. The Board recommend a dividend for the whole of the past year on the ordinary shares numbered 1 to 160,000 inclusive, at the rate of 15 p.ct., tax free, as well as a dividend as from May 1, 1920, or such earlier date as the shares were paid for in full, on shares numbered 160,001 to 200,000 inclusive, at the rate of 15 p.ct. per annum, tax free. The sum of £13,000 is placed to reserve, and £18,272 carried forward, against £13,219 brought in.

Silsden Gas-Works Accounts.—The seventeenth annual financial statement on the Silsden District Council's gas-works, presented recently, showed that the gas manufactured was 29,597,000 c.ft.—an increase of 1,304,000 c.ft. over that of the previous year. The gas sold was 25,670,600 c.ft., 651,000 c.ft. was used for public lighting, and 979,500 c.ft. was used on the works; making a total of 27,301,700 c.ft. accounted for, as against 26,047,800 c.ft. last year. The gas made per ton of coal was 13,077 c.ft., and the quantity accounted for per ton of coal was 12,070 c.ft., as against 11,300 c.ft. last year. There was an increase of gas used on the works owing to the gas-engine having to be run for exhaust purposes when the works were without steam, on account of a boiler breakdown. In all departments production had been better than for some years past. The return from residuals was £2698, as against £1657 last year; the chief items of increase being tar and exported coke. Owing to the fall in values of residuals, there was no prospect of a high return in the coming year. Financially, the undertaking showed a gross profit of £1514, despite higher expenses, as against a profit of £338 last year; but after paying capital charges there was a net loss of £412.

Complaints at Seaham Harbour.—Complaint as to the quality of gas supplied by the local Company was made at a meeting of the Seaham Harbour Urban District Council by Mr. R. Boad, who declared that tradesmen wanted electric light, and nobody was in a position to supply it. The gas they were getting was dirty, he asserted; and though the Company were right at the pit mouth, they were among the first to cease the supply owing to the industrial crisis. He moved that they consider the question, with the object of constructing an electricity station; and this was agreed to.

A Coal Godsend at Brighouse.—The recent discovery of a good seam of soft coal on a farm at Brighouse has provided enough coal during the past couple of weeks to maintain the local gas service and practically all local factories and engineering shops, to permit the restoration of the Halifax tramway service to the normal, and to send supplies to Bradford and Huddersfield, and even a small quantity to other towns. Digging operations have shown that coal-getting took place here many years back, before either the railway or the canal existed—that is, more than 150 years ago. The quarrying company in charge have now 1000 men working in three shifts, getting about 1200 tons per day.

Increase Proposal Rejected at Ripon.—The price of gas at Ripon is to remain at 4s. 9d. per 1000 c.ft. The Gas Committee had recommended that it should go up to 5s. 6d., the maximum allowed; and the reason put forward was that, owing to the present stress, the Gas Committee had lost in round figures £300, and estimated the loss to the end of June at £500. The Council, however, rejected the proposal; and the curious part of the matter is that when the vote was taken, ten members voted in favour of the price remaining as at present, and the three remaining members did not vote. There seems now to be a tendency to disclaim any connection with the proposal, which was so unpopular.

Thornaby and the Price of Gas.—A resolution was moved, at a meeting of the Thornaby-on-Tees Corporation last week, submitting to the neighbouring authority of Stockton that their decision to increase the price of gas supplied to Thornaby to 4s. 11d. per 1000 c.ft. (*plus* 10 p.ct. if unpaid in fourteen days) was, under present industrial conditions, unjustifiable. Mr. Oxberry said at first glance it would appear that Thornaby had little ground for complaint, seeing that they were on the same scale as Stockton; but the gas-works had returned altogether over £200,000 to the relief of rates, and Thornaby, who had contributed to the revenue, had never received a penny in return. As to the price of gas, at Middlesbrough it was 2s. 8d. (with a prospective rise of 4d.), at Darlington 3s. 9d., and at Sunderland 4s. per 1000 c.ft. Stockton could not legally charge the price they were putting forward, with the 10 p.ct. addition. The slot-meter consumers would be paying at the rate of 5s. 6d. per 1000 c.ft., or 6d. more than the Act allowed. Mr. Shepherd, who supported, said it was unfair that power consumers should be receiving preferential treatment at a price below cost. The resolution was carried unanimously.

MAIN'S
SURREY COOKER

An ideal cooker for Housing Scheme requirements. Fitted with high efficiency removable burners, reversible grill, cast or malleable bars; adjustable stand and plate rack if required; spacious oven. Our list gives details of this and other modern cookers.

R. & A. MAIN, LTD.,
EDMONTON, N. 18., FALKIRK, &c.

Dundee Gas Accounts.—The income for the past year of the Dundee Gas Commissioners was £370,951, or £81,577 more than in the previous year. The sale of gas shows an increase of 95 million c.ft. The expenditure, of course, increased. In manufacture, distribution, &c., the rise amounted to £94,000, owing to the high cost of coal, wages, and material. The net result of the year's working is a loss of £23,952.

Messrs. Higginson & Co. announce that letters of allotment in respect of the issue of £237,860 of 7½ p.ct. redeemable debenture stock of the Cardiff Gas Company were posted last Wednesday.

Last Thursday and Friday week the employees of the Littlehampton Gas Company, accompanied by their wives and friends, had an enjoyable trip to the New Forest. Luncheon was served at Southampton, the chair being occupied on Thursday by Mr. Albert Linfield (a Director), and on Friday by Mr. A. W. Elton (the Manager).

At the works of Messrs. Hall & Stell, Ltd., textile machine makers, of Keighley, a large gas-meter fired, the occurrence being due, apparently, to the flames travelling back through the piping, owing to the low pressure consequent on coal shortage, when a workman was lighting the gas for the brazing hearth. The fire brigade were summoned; but it was found that the only damage was the destruction of the meter itself.

A new organization, under the title of the Federation of British Propaganda Societies, has been formed, the object of which is to co-ordinate the work of propaganda societies and, as far as possible, prevent overlapping. Already about fifteen propaganda societies have expressed their willingness to join. His Grace the Duke of Northumberland has consented to act as President, and Sir Henry Birchenough, K.C.M.G., &c., is the Treasurer. The General Secretary is Mr. David Gilmour, O.B.E., Sicilian House, Southampton Row, W.C., who will be willing to give further information to readers.

STOCK MARKET REPORT.

THERE is very little change to note in the condition of things on the Stock Exchange last week. Business was extremely quiet. Ascot races and the general sunshine were responsible for a number of absentees, besides which the general aspect of national affairs was still too dark and doubtful for any but the boldest to speculate. The best that can be said is that the tone was the least depressed at the close.

The gilt-edged market did not suffer much, though starting badly. Home Government issues pretty well recovered what they had lost; Friday's figures for the big four being: Consols 45½-46, War Loan 87 5/16-87 9/16, Funding 71⅞-72⅛, Victory 77-77¼. Bonds and corporation issues did fairly well. Home Rails were dull and quiet, and Argentines weakened. In the Foreign Market there were varying currents. French, Belgian, Mexican, and Brazilian came in for some support; but Japanese, Chinese, and Chilian were lower.

The Miscellaneous Market had not a good time. Rubber and Oil were weaker, and Industrials in general were dull; but Iron and Steel concerns were an exception.

Business in the Gas Market showed a falling-off in point of activity in common with the other departments in general, and probably from the same cause; but there was no lessening in firmness, and variations of price were upward except in one or two special cases. In the London companies there was little change; but Commercial commanded higher figures. In the Suburban and Provincial group, Brentford "A" and "B" made further advances. Several debenture issues came out better on *ex div.* adjustments. In Continentals, Imperial was very quiet at the same prices; but Union was lowered. Primitivas were quiet and unchanged. Bombay was lower on the deferred dividend.

Bargains done for cash during the week were as follows: On Monday, Brentford "A" 70, Gas Light ordinary 55, 55⅝, 55⅝, ditto preference 58, Imperial Continental 133, 135 (and exceptional 125, 132), ditto debenture 80⅜, Primitiva preference 27s., South Suburban debenture 73. On Tuesday, Bournemouth 5 p.ct. 7⅜, Brentford "A" 70, Commercial 4 p.ct. 58½, ditto 3½ p.ct. 55, Continental Union preference 30, Gas Light ordinary 55, 55⅛, 55⅛, ditto debenture 50, Imperial Continental 134, Primitiva 9s., ditto preference 27s., 27s. 3d., 27s. 4½d., South Metropolitan 67⅛, 68, 68½, ditto debenture 47⅜, Tottenham "B" 53½, 54⅜, ditto debenture 53½, Aldershot 4 p.ct. debenture 52, 52½. On Wednesday, Bournemouth 5 p.ct. 7⅜, Gas Light ordinary 55½, Imperial Continental 133, 133½, 134 (and exceptional 118¾), South Metropolitan 67½, 67⅜, Southampton 56, 56½. On Thursday, Brentford "A" 70, ditto "B" 62½, Continental Union 17, Gas Light ordinary 54½, 54⅜, 55, 55⅛, 55½, ditto maximum 42½, ditto preference 58, 58⅜, Imperial Continental 133, 134½, Primitiva 9s., ditto preference 26s. 9d., South Metropolitan 67⅜, 68, Tottenham "B" 54⅜, ditto debenture 52⅝, 53½, Toronto Consumers 76¼. On Friday, Bombay 3⅝, Brentford "A" 68, ditto "B" 61, ditto preference 68, Gas Light ordinary 55½, ditto preference 58½, 58⅝, 58½, 58¾, Imperial Continental 133, 133½ (and exceptional 100), San Paulo preference 5½, South Metropolitan 67½, Tottenham "B" 54½, 54⅜, Cardiff 7½ p.ct. debenture 49½, 49⅞, 50⅜.

In the Money Market, the position has fluctuated almost from day to day, with alternations of pressure and ease; the latter being in the ascendant at the close. Discount rates were unaffected, and ruled steady all through the week. Silver varied, and stood at 34⅞d. on Friday. The Bank rate is 6½ p.ct., as fixed on April 28.

ANTE-WAR PRICES AND DIVIDENDS, LATEST DIVIDENDS, AND LAST WEEK'S BARGAINS.

Issue.	Share.	When ex-Dividend.	Ante-War Dividend & Bonus.	Last Dividend.	NAME.	Closing Prices, July 30, 1914.	Present Prices.	Lowest and Highest Prices of Bargains.
£			p.cp.					
182,049	Stk.	Mar. 11	4	4%	Aldershot 4 p.c. Pref. .	...	53—58	...
1,551,868	,,	Apl. 14	2½	3⅛%	Alliance & Dublin Ord.	59—64	39—44	...
374,000	,,	Jan. 13	4	4%	Do. 4 p.c. Deb.	76—79	47—52	...
280,000	5	Oct. 28	7½	8%	Bombay, Ltd. . . .	5¼—6¼	3⅛—4⅛	3⅛
100,000	5	Feb. 25	16	5%	Bournemouth Gas and Water { 5 p.c. . .	...	7⅛—8⅛	7⅛
383,110	10	,,	7	7%	B 7 p.c. .	15—15½	8¼—9¼	...
115,000	10	,,	6	6/-	Pref. 6 p.c.	13¼—14	7¼—8¼	...
162,065	—	Dec. 30	—	4%	4 p.c. Deb.	...	55—60	...
992,045	Stk.	Feb. 25	14	30/-	Brentford A Consolid. .	261—266	66—71	68—70
734,920	,,	,,	11	26/3	Do. B New . .	204—209	60—65	61—62½
55,000	,,	,,	5	5%	Do. 5 p.c. Pref. .	109—111	68—73	68
221,400	,,	June 15	4	4%	Do. 4 p.c. Deb. .	91—93	56—58*	...
214,775	,,	Mar. 11	11	7½%	Brighton & Hove Orig. .	208—213	95—105	...
244,200	,,	,,	8	5⅛%	Do. A Ord. Stk.	154—159	65—75	...
1,287,500	Stk.	July 29	5	5%	Bristol 5 p.c. max. . .	...	...	...
530,000	20	Mar. 30	12½	10%	British	44—45	22—24	...
120,000	Stk.	Dec. 30	4	4%	Do. 4 p.c. Deb. Stk.	88—90	50—55	...
245,771	,,	,,	4	4%	Buenos Aires 4 p.c. Deb.	85—87	37—40	...
100,000	10	May 27	—	6%	Cape Town & Dis., Ltd.	1½—2½	6¼—7¼	...
100,000	10	Apl. 28	—	4½%	Do. 4½ p.c. Pref. .	4—6	4½—5½	...
100,000	Stk.	Dec. 30	4½	4½%	Do. 4½ p.c. Deb. Stk.	70—75	55—60	...
157,150	,,	Feb. 26	5	5%	Chester 5 p.c. Ord. . .	108—110	...	...
1,513,280	,,	Feb. 25	5/9/4	30/-	Commercial 4 p.c. Stk.	106—108	55—60	58½
560,000	,,	,,	5½	26/3	Do. 3½ p.c. do.	103—105	52—57	55
475,000	,,	June 15	3	3%	Do. 3 p.c. Deb. Stk.	69¼—71¼	42—45*	..
800,000	,,	Dec. 11	4	—	Continental Union Ltd.	76—79	17—22	17
200,000	,,	,,	7	—	Do. 7 p.c. Pref.	115—118	30—40	30
51,600	,,	Feb. 5	15	10%	Croydon A 10 p.c. . .	...	125—135	...
278,400	—	,,	12	7%	Croydon B and C 7 p.c.	..	95—105	...
492,270	Stk.	—	6	4⅛%	Derby Con. Stk. . .	123—125	...	...
55,000	,,	—	4	4%	Do. Deb. Stk. .	102—104	...	...
1,002,180	10	Jan. 29	10	5/0	European, Ltd. . . .	17½—18	6¼—7¼	...
16,298,975	Stk.	Feb. 10	4/17/4	30/-	Gas { 4 p.c. Ord. . .	98—102	54½—56½	54½—55½
2,600,000	,,	,,	3½	26/3	Light { 3½ p.c. max. .	76—79	42—45	42½
4,062,235	,,	,,	4	4%	and { 4 p.c. Con. Pref.	96—99	56—59	58—58½
4,674,850	,,	June 15	3	3%	Coke { 3 p.c. Con. Deb.	72½—74½	48—51*	50
130,000	,,	Dec. 11	10	10%	10 p.c. Bonds. .	...	...	...
82,500	,,	Mar. 11	5	3½%	Hastings & St. L. 5 p.c.	...	48—53	...
258,740	,,	,,	3½	2½%	Do. 3½ p.c.	87—89	34—39	...
70,000	10	May 12	11	5%†	Hongkong & China, Ltd.	16¼—16½	5—6	...
86,600	Stk.	Mar. 11	9	5½%	Hornsey 7 p.c. . . .	...	75—85	...
131,000	,,	Mar. 30	7⅞	3½%	Ilford A and C . . .	151—154	76—81	...
65,780	,,	,,	6⅛	2⅞%	Do. B	115—118	55—60	...
65,500	,,	Dec. 30	4	4%	Do. 4 p.c. Deb. . .	92—94	54—56	...
1,976,000	,,	May 27	9	5%†	Imperial Continental .	150—160	132—137	133—134½
1,235,000	,,	Feb. 10	3½	3½%	Do. 3½ p.c. Deb. Red.	84—86	76—81	80¾
235,242	,,	Mar. 30	6½	3½%	Lea Bridge Ord. 5 p.c. .	119—121	65—70	...
2,498,905	,,	Feb. 26	10	37/6	Liverpool 5 p.c. Ord. { A.	211—213	...	...
						B. 146—148	...	...
306,083	,,	June 26	4	4%	Do. 4 p.c. Pr. Deb. Stk.	...	...	...
165,736	,,	Feb. 25	7/5/6	32½%	Maidstone 5 p.c. . .	...	52—57	...
75,000	5	June 11	6	5%	Malta & Mediterranean	4¼—4⅝	1⅝—2⅛	...
250,000	100	Apl. 1	4½	4½%	Met. of Melbourne { 4½ p.c. Deb.	99—101	88—93	...
541,920	Stk.	May 27	4	6%	Monte Video, Ltd. . .	11½—12	60—70	...
1,875,892	,,	Feb. 25	4½	3½%	Newcastle & Gatsh'dCon.	98½—99½	59½—60½	...
529,705	,,	Dec. 30	3½	3½%	Do. 3½ p.c. Deb.	82—83	50—52	...
15,000	10	Mar. 11	—	8%	North Middlesex 10 p.c.	...	12⅜—13⅜	...
55,940	10	,,	7/14/0	53%	,, ,, 7 p.c.	14—15	7⅛—8⅛	...
300,000	Stk.	May 12	8	8%	Oriental, Ltd. . . .	117—122	87—92	...
60,000	5	Mar. 26	10	1/-	Ottoman, Ltd. . . .	7½—7⅞	2—3	...
60,000	50	Feb. 25	13	7½%	Portsea Island, B . .	128—131	65—70	...
100,000	50	,,	12	6½%	Do. C . .	118—121	50—55	...
249,980	5	April 29	8	8%	Primitiva Ord. . . .	5½—6	⅛—⅜	9/-
499,960	5	June 26	5	—	Do. 5 p.c. Pref. .	4½—5	1¼—1½	26/9—27/4½
521,600	100	June 1	4	4%	Do. 4 p.c. Deb. .	91—93	65—67	...
600,000	Stk.	Jan. 27	4	4%	Do. ,, ,, 1911	...	37—40	...
346,198	,,	Dec. 30	4	4%	River Plate 4 p.c. Deb.	85—87	37—40	...
150,000	10	Mar. 30	6	6/-	San Paulo { 6 p.c. Pref.	10½—11	5½—6½	5½
125,000	50	Jan. 3	3	5%	{ 5 p.c. Deb.	47—49	35—40	...
135,000	Stk.	Mar. 30	10	5%	Sheffield A	223—224	62—64	...
209,984	,,	,,	10	4½%	Do. B	222—224	62—64	...
523,500	,,	,,	10	3½%	Do. C	220—222	59—61	...
133,201	Stk.	Sept. 15	4	4%	Shrewsbury 5 p.c. . .	...	...	...
90,000	10	Sept. 30	9	9%	South African	10½—11½	9—11	...
6,609,895	Stk.	Feb. 10	5/4/0	5%	South Met. Ord. . . .	111—113	67—69	67½—68½
250,000	,,	Jan. 13	—	5%	Do. Red. Pref. .	...	90—92	...
1,895,445	,,	,,	3	3%	Do. 3 p.c. Deb. .	72½—74½	46—49	47½
224,820	,,	Feb. 25	8½	7½%	South Shields Con. Stk.	157—159	85—87	...
1,087,795	,,	,,	6	3½%	S'th Suburb'n Ord. 5 p.c.	114—116	58—63	...
368,837	,,	Dec. 30	5	5%	Do. 5 p.c. Deb. Stk.	116—118	72—77	73
647,740	,,	May 12	7½	3½%	Southampton Ord. . .	99—102	55—58	56—56½
121,375	,,	Dec. 30	4	4%	Do. 4 p.c. Deb. Stk.	...	57—59	...
120,000	,,	Feb. 25	—	3½%	Tottenham { A 5 p.c. .	135—138	57—62	...
782,275	,,	,,	6	2½%	District { B 3½ p.c. .	115—117	50—55	53½—54½
181,255	,,	June 15	4	4%	{ 4 p.c. Deb.	87—89	52—55*	52½—53½
182,380	10	Dec. 30	5	—	Tuscan, Ltd. . . .	5—6	1—2	...
149,900	10	July 1	5	5%	Do. 5 p.c. Deb. Red.	93—95	45—50	...
236,476	Stk.	Feb. 25	5	3½%	Tynemouth 5 p.c. max.	108½—109	68—70	...
					Wandsworth, Wimbledon, and Epsom—			
30,000	,,	Feb. 25	8½	47/6	Wandsworth A 5 p.c.	151—156	78—83	...
255,636	,,	,,	6½	32/6	Do. B 3½ p.c.	129—134	55—60	...
108,075	,,	,,	—	33/3	Do. C . . .	...	55—60	...
140,865	,,	,,	—	33/3	New Ordinary . . .	...	55—60	...
352,000	,,	,,	6½	26/3	Wimbledon 5 p.c. . .	117—122	57—62	...
98,000	,,	,,	6½	32/6	Epsom 5 p.c. . . .	121—126	55—60	...
89,418	,,	Dec. 30	5	5%	5 p.c. Deb. Stk. . .	66—69	40—45	...

* Ex Div. † Next dividend will be at this rate.

HEAD, WRIGHTSON, & CO., LD., for PURIFIERS, &c. T. & J. BRADFORD, LTD., 24, VICTORIA STREET, S.W. 1 MANCHESTER.